EDISON ELECTRIC INSTITUTE BULLETIN

OCTOBER, 1942

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EDISON ELECTRIC INSTITUTE

THE ELECTRIC LIGHT AND POWER INDUSTRY

Current Statistical Data Covering 100 Per Cent of Industry

August, 1942

SOURCE AND DISPOSAL OF ENERGY—MONTH OF AUGUST

	1942	1941	%
GENERATION* (Net)			
By Fuel Burning Plants	10,958,454,000	10,614,800,000	+ 3.2
By Water Power Plants	5,317,076,000	3,930,000,000	+35.3
Total Generation	**16,275,530,000**	**14,544,800,000**	**+11.9**
Add—Net Imports Over International Boundaries	(Details	73,105,000	.....
Less—Company Use	Not	226,356,000	.....
Less—Energy Used by Producer	Yet	272,573,000	.....
Net Energy for Distribution	Available)	14,118,976,000	.....
Losses and Unaccounted For		2,031,818,000	.....
Sales to Ultimate Customers	**13,650,227,000**	**12,087,158,000**	**+12.9**

CLASSIFICATION OF SALES

NUMBER OF CUSTOMERS—As of August 31st			
Residential or Domestic	26,471,924	25,582,828	+ 3.5
Rural (Distinct Rural Rates)	1,097,040	967,292	.....
Commercial or Industrial:			
Small Light and Power	4,271,672	4,285,648	− 0.9
Large Light and Power	148,903	173,437	
Other Customers	121,228	115,982	.....
Total Ultimate Customers	**32,110,767****	**31,125,187**	**+ 3.2**
KILOWATTHOUR SALES—During Month of August			
Residential or Domestic	2,104,059,000	1,969,498,000	+ 6.8
Rural (Distinct Rural Rates)	386,312,000	329,429,000	+17.3
Commercial or Industrial:			
Small Light and Power	2,328,002,000	2,131,426,000	+ 4.2†
Large Light and Power	7,727,084,000	6,730,427,000	+16.5†
Street and Highway Lighting	150,799,000	154,246,000	− 2.2
Other Public Authorities	365,286,000	258,843,000	+41.1
Railways and Railroads:			
Street and Interurban Railways	327,809,000	300,348,000	+ 9.1
Electrified Steam Railroads	194,531,000	173,147,000	+12.4
Interdepartmental	66,345,000	39,794,000	+66.7
Total to Ultimate Customers	**13,650,227,000**	**12,087,158,000**	**+12.9**
Revenue from Ultimate Customers	**$238,059,100**	**$223,514,900**	**+ 6.5**

** Subject to Revision following state by state analysis now under way.
† Based on changes made in same classifications both years.

RESIDENTIAL OR DOMESTIC SERVICE (Revised Series)

AVERAGE CUSTOMER DATA—For the 12 Months Ended August 31st			
Kilowatthours per Customer	1,013	974	+ 4.0
Average Annual Bill	$37.38	$36.72	+ 1.8
Revenue per Kilowatthour	3.69¢	3.77¢	− 2.1

* By Courtesy of the Federal Power Commission.

Vol. 10, No. 10, EDISON ELECTRIC INSTITUTE BULLETIN; published monthly. Entered as second-class matter Aug. 17, 1933, at the post office at Philadelphia, Pa., under the act of March 3, 1879. Publication office, 56th and Chestnut Sts., Philadelphia, Pa. Editorial office, 420 Lexington Ave., New York, N. Y. Subscription rate $2.00 per year in the United States; $3.00 per year in foreign countries.

The Edison Electric Institute does not assume responsibility for, nor necessarily endorse or approve, statements made by contributors to the BULLETIN.

EDISON ELECTRIC INSTITUTE BULLETIN

Volume 10 OCTOBER, 1942 No. 10

The Business of War

By C. W. Kellogg

President, Edison Electric Institute

A talk before the Indiana Electrical League, Indianapolis, Ind., October 22, 1942

THE war has now progressed to the point of complete predominance over all else. What at first might have seemed like a relatively temporary dislocation of our national economic and social life, now bids fair to settle down to a long term struggle, wherein the prosecution of the war becomes not only the one and only thing that counts, but also the principal business of the country. Instead of thinking of war activities as something that interferes with civilian life, we have come to realize that we must reverse the viewpoint and think of war as the main business of the country and of civilian life as being just enough to enable everybody to contribute the maximum to the war effort.

Before Pearl Harbor

Even before Pearl Harbor, which brought our country to the condition of an actual belligerent, the war-preparedness effort of this country was already of huge proportions. The nation's defense expenditures in December, 1941, (expanded to a twelve months basis) were at the rate of $24 billion per annum—a rate greater by 43 per cent than those of our largest year in the first World War, attained before we became an actual member of the United Nations in the present global conflict! Since Pearl Harbor the nation's war expenditures have grown by leaps and bounds and for last month, September, the highest to date, the rate of such expenditure (on a twelve months basis) had grown to $68 billion. In the nature of the case these monthly expenditures must sometime reach a maximum; but we can say that so far at least their growth has not stopped, nor has the rate of growth materially decreased.

Regardless of what the future may show, the current rate of government expenditure for war ($68 billion) represents 60 per cent of the current national income (estimated at $115 billion). If to these strictly war expenditures we add $15 billion, representing the non-war expenditures of the Federal Government plus state and local governments, we have a grand total of 72 per cent of the entire national income being now used either to run the government or to protect our national existence. This would seem to leave only 28 per cent to pay for all civilian activity, including day to day living. The fact is however that two-thirds of the war expenditures are being made with borrowed money; but their size shows how important it is for our future economic welfare to raise the highest feasible part of the war costs from current taxes.

It goes without saying that the relative war effort to which we have already attained could not have been achieved without the most profound changes in the economic field. The necessity for doing so much (especially so much new work) in so short a time, has produced shortages in materials whose effects have been catastrophic. It has required the stopping of practically everything which does not help in the war or in keeping people fed, clothed and healthy; and this in turn has meant the wiping out of thousands of industries which could not get raw materials nor convert their manufacturing facilities to war work.

What I have said up to now is merely by way of background, with which you are all familiar. You are naturally interested particularly in how making war our principal national business affects the electric industry.

Speaking very generally, the electric business has three main aspects:

1. The manufacture and distribution of electric energy, which is the function of the utility companies.
2. The utilization by home, store and factory of this energy, in facilitating daily life, commerce and manufacturing, which is largely your job.
3. The manufacture and sale of the apparatus needed for both of the purposes above stated, which is the manufacturers' job.

It is my plan to discuss briefly how the Business of War reacts on each of these aspects. Each is affected in a different way; yet, all being but parts of the electric business as a whole, they react profoundly on one another.

War Effect on Utilities

First, as to the utilities: The outstanding characteristic of modern war is the preponderant need for manufactured products. The skill, ingenuity and valor required of the fighting forces are the same as they have been for ages past; and in these qualities, thank God, our fighting men have shown themselves as fine in this war as in any that was ever waged. This war has also shown, however, in many tragic cases, that valor and leadership alone are well nigh powerless when pitted against superiority in planes, ships, tanks, guns and the many other mechanical devices which have been developed for military and naval purposes. In the tremendous industrial effort required to produce these tools of combat, electricity enters as the handmaiden of all. As well hope to manufacture without capital and labor as without the power to give these elements life and force.

In this respect, power plays the same role in the Business of War as it does in the pursuit of peace. For a long time the truth of this statement was not fully realized. Many people, impressed with the huge mass of new war material that had to be produced, believed that a corresponding amount of additional electric power would be required. It was estimated at one time by some that 2.75

kilowatthours of electricity would be needed for each dollar of war expenditure. In the early stages of war preparedness this seemed to be the case; but I believe this early indication appeared at a time when civilian activities still continued relatively unabated, thus causing the war load to be superimposed upon them. However, as the Business of War became, as it is today, preponderant, the net effect grew less and less.

War Energy Requirements

May I give some figures bearing on this point. Taking the entire preparedness period beginning in June, 1940, now well over two years ago, the greatest growth of industrial electric energy output of the nation in any month over the corresponding month the year before, occurred in September, 1941, over a year ago—the gain in that month being about 1,650,000,000 kwhr. For that same month war expenditures showed a corresponding gain of $1,200,000,000 — a ratio of 1.39 kwhr of additional industrial energy per dollar of additional war expenditure. Since last September we have had Pearl Harbor and our own direct entrance into the war and for the month of August this year the growth in our war expenditures over the previous August was $4 billion. If the ratio of additional industrial energy per dollar of additional war expenditure to which I referred before (2.75) had then been effective, the growth in industrial energy for the month of August alone would have been 11 billion kwhr. Yet in fact it was just 1/10 of that figure (1.10 billion).

Additional Generating Equipment Cancelled

In general, the larger the war expenditures have progressively grown, the smaller has been their relative effect on total power requirements on an incremental basis. As a result of this experience, the War Production Board, within the last two months, has ordered the discontinuance of work on a total of 2,200,000 kilowatts of electric generating capacity, in various stages of completion by 85 electric utility companies. This result is particularly striking in that when this generating equipment recently cancelled was ordered, the maximum annual war expenditure then estimated by the government has since been increased about threefold. All of this has been the logical outcome of the fact that the electric utility industry is a service business, so that as, and to the extent that, the war became the principal business of the country, non-war activities were pinched off and their place taken by war industry — total energy requirements remaining about as they would be in any boom period.

It is worth noting that while the war demands have produced tremendous displacement of civilian industry, there are also reactions occurring in war preparations themselves, some of which are now decreasing in scope or will tend to do so in the near future. The huge sums expended initially for construction of new plants for war production are once-for-all expenditures which will not have to be repeated currently through the war period. Even in production itself, the first great effort necessary was to produce huge reserve supplies of needed munitions. After these supplies have been created, their maintenance is less of a job. For example, in the matter of ammunition, the *New York Times* reported last month that the supply had run so far beyond the ability of the armed forces to use it, that in certain classes an overall reduction of about 40 per cent in production had been ordered. Some other war requirements are not relatively as far advanced, but the point I am making is that reduced requirements for one purpose can be transferred to fill the gap in others. The phase of war production we have now entered will witness more and more of these mutual readjustments of the scope of war production effort.

Carrying Peaks

Considering power from the viewpoint of ability to carry peak loads rather than merely energy requirements, total generating capacity at the end of this year will be about 47,000,000 kw, while the sum of expected non-coincident peak loads will be about 38,000,000 kw. This represents a draft on reserves of about 1,100,000 kw since the preparedness program started over two years ago. This draft (of approximately 10 per cent) seems trifling in view of the arrangements that have been made to curtail use over peaks for civilian purposes, if and when such curtailment should be necessary. Present indications are that the load factor in 1942 will be about 2 per cent higher than it was last year, producing electric utility output for this year of about 190 billion kwhr.

We may conclude therefore that for the Business of War the electric generating capacity of the nation is ample. There are clearly much more knotty problems involved in the matter of utilization by customers, which is the second aspect I planned to discuss.

Effects on the Home Front

War demands for copper, aluminum and steel have made it necessary to stop the running of new services and to discontinue the manufacture of household electrical equipment. What this means to the residence consumer and to the thousands of electrical contractors and dealers throughout the land can be grasped from a few figures. Last year 1,375,000 new residential and rural customers were added to utility lines. This year we added 500,000 in the first six months but from there on the growth is slowing down. Last year about 18,000,000 major domestic electric appliances were sold; now this flood is reduced to a trickle released from time to time from frozen stocks. In dollar value, major domestic equipment sales in 1941 were 50 per cent greater than the entire gross receipts of the utilities in that year from residential and farm service. The electric wiring incidental to the growth in customers and equipment I have mentioned added substantially to the total of business done by electrical contractors and dealers.

This is a mighty big chunk of business to be virtually wiped out by the Business of War. The picture is however not so black as these figures alone would seem to make it. The other viewpoint is to consider the maintenance requirements of the huge total of household appliances that have been sold through the years.

Great Size of Residential Equipment

It has been estimated that by the end of 1941 there were about 125,000,000 electrical appliances in the homes of the nation. In the course of nature, a very large number of these will reach the end of their natural life each year; and yet the need for the service they render to their owners will not end. The maintenance and upkeep of this great total of equipment should represent a correspondingly great volume of business for the electrical contractor and dealer. The problem is a two-fold one; not only the actual repair of equipment in use when requested by the user, but also the investigation of the amount of such equipment that has been set aside by customers from time to time in the past as it got out of order, which could now be repaired and again placed in service.

In this latter point particularly the utilities should work hand in hand with the contractors and dealers. (In making this statement here I know I am merely "carrying coals to Newcastle," because it was your Mr. A. C. Crandall, Vice Pres-

(*Continued on page* 390)

The Power Outlook for New England

By S. Ferguson
President, The Hartford Electric Light Company

A statement made before the New England Council, Boston, Mass., Sept. 18, 1942

THREE events have taken place during the last six months which are of major importance to the electric companies of New England, in common with the industry as a whole, particularly to those located on the Eastern Seaboard. These events are:

1. The loss of the Atlantic tanker fleet by submarine sinkings and diversion to Naval service.
2. The ruling of the President in April by which the entire control of the industry was placed in the War Production Board thus eliminating all permanent Federal Bureaus and other agencies.
3. The War Production Board order of May 1, 1942 known as Limitation Order L-94, covering the operations of the entire industry.

Commenting briefly on each:

1—The loss of the Atlantic tanker fleet requires all the steam plants of the East to change from the use of oil to coal. This change is the more serious to New England because of the additional loss of the deep sea collier fleet which throws the burden of supplying a large percentage of the coal onto the railroads. In consequence it is essential that every coal storage yard in New England be filled during the summer in order to avoid a winter shortage when storms will inevitably cause congestion at the gateways. How important is this question of ample stock is indicated by the fact that New England companies are spending large amounts to increase their yard and coal handling facilities. In our particular case, we are spending over $600,000 to enable us to make up for the million and a half barrels of oil on contract but which will not be received; and by the fact that we have been sharing in the purchase by the New England Power Company of power from New York City, transmitted by way of Albany, to take the place of power usually generated in Hartford—thus enabling Hartford to store, instead of burning, the equivalent amount of coal.

2—The transfer of all control over the industry from permanent Federal agencies to the War Production Board has had a very beneficial and stimulating effect since the industry can now be sure that all orders and requests that come from Washington are based solely on war necessities; the controlling agency being of a temporary nature can have no interest in using the war as a convenient medium with which to augment bureaucratic power and influence.

No longer is the industry deprived of essential copper or steel while at the same time compelled to watch the use of such material in the development of Federal projects which cannot be completed in time to assist in the war effort, or which, as in the case of the construction of the "Ark-La" transmission line by the Rural Electrification Authority, have no war-necessity justification whatsoever.

The restrictions in the use of materials by the industry are very real, and civilian service is bound to suffer in many accustomed but non-essential respects. To date however there has been no lack of the power required in the production of the increased volume of steel, copper and aluminum—and there is room for substantial further expansion without curtailment of civilian uses.

3—Limitation Order 94 requires that all companies interconnect their systems where practical and operate regionally as an integrated whole. The New England States are grouped as a unit and therefore each (except possibly Maine) will fare alike with its neighbor states in the event that curtailment of civilian uses should later be required. Fortunately ample generator capacity has been provided in advance by the New England companies and no power shortage will occur unless caused by lack of fuel, or possibly to help out Canada's war industries in case poor water conditions there should create a temporary shortage. Order L-94 provides in advance for meeting any such condition in an orderly fashion with a minimum of interference to civilian uses.

There are three radically different situations, any one of which could result in the curtailment of civilian usage. These are:

First, a lack of generating capacity sufficient to carry the peak loads, which universally occur for one or possibly two hours a day in November and December. Such a condition might well exist in territory served exclusively or primarily by steam driven generators. The territories served by the New York or Boston Edison companies are typical illustrations. Shortage here would be only during peak hours of work in the communities served and met by curtailments during the limited hours of peak load. Ample capacity would exist throughout the remaining 22 hours.

I believe that I am justified in reassuring you as to this situation as to New England as a whole since it has (or will have by the time of the December peak loads) an excess of fully 200,000 kw over and above the probable maximum peak. I do not mean that there may not be a lack of full capacity in some particular local territory which is not adequately connected to the main transmission systems but only that there will be no declaration of a general shortage area from this particular cause unless accidents in unprecedented numbers occur to the larger turbines in Boston, Providence or Hartford. 200,000 kw is not as large a margin of safety as it sounds if we express it as a percentage of the expected peak of approximately 2,000,000 kw.

The second cause for shortage is confined to territories exclusively or primarily served by water-driven generators. It makes its appearance during periods of low stream flow when there is insufficient water to drive the generators at their full ratings throughout the period each day when factories are operating. In normal times this period covers eight or 10 hours a day. The practice is to pond the stream flow occurring during the balance of the 24 hours for use at the time of factory operation. A shortage of water is greatly aggravated by the wartime two and three-shift factory operation. Such operation requires continuous use of the stream flow, permits of no ponding, and thus greatly reduces otherwise available daytime capacity.

Seasonal storage reservoirs usually supply the needs of such territories and under normal operation retain enough water to handle any peak-load requirements without difficulty. Three-shift operations however tend to greatly deplete these reservoirs so that even if there is sufficient water to handle 24-hour operating requirements during periods of low stream flow there will be insufficient

water left on hand for the winter peaks. The Southeast territory, last fall, was illustrative of this situation. The large requirements of expanded aluminum plants combined with deficient rainfall created a condition which could be met only by civilian curtailment and transfer of energy from territories where such conditions did not exist.

Here again, the companies in New England have been very forehanded in conserving the waters stored in all existing seasonal reservoirs. These reservoirs were completely filled this spring and contain water sufficient for the generation of over 300,000,000 kwhr—two-thirds of which is contained in those built and owned by The New England Power Company. Normally that company would now be using this hydro power to supplement the low river flow in supplying the needs of their customers; but instead, and at great expense, they are operating their inefficient old steam plants (normally held idle as emergency reserves) and are buying power from Boston and elsewhere.

The same applies to the reservoirs of the Western Massachusetts Companies and of The Connecticut Light & Power Company in order that this very considerable amount of power may be available to New England in the event of breakdowns of steam turbines at times of peak loads or in the event that congestion on the railroads should create a fuel shortage during the winter months.

We can thus, in New England, also disregard the second cause for curtailment of civilian use.

Lack of fuel is the third cause for shortage. This may be due either to a stoppage of fuel production or congestion in transportation. Such a situation faced New England this year. Scarcity of oil, as previously stated, has necessitated an almost complete shift to coal and what is worse, coal transportation (due to the submarine situation and the Navy's need for large colliers) has largely shifted from water to rail thus throwing a tremendous burden on the railroads.

The answer to such a problem lies in an all-out effort to store the maximum amount of coal during times of our maximum streamflow, when coal-burning is at a minimum, and in this effort all New England Companies have been, and are, doing their part.

New England has storage capacity for about 1,300,000 tons of coal. If these storage yards and the seasonal reservoirs are full, as of December 1, the territory will not suffer from the inevitable winter reduction of rail shipments due to the congestion of the gateways which will accompany winter storms.

Frankly, this "if" has had us all worried and great efforts have been made to insure its elimination. In March the total coal in storage did not exceed 800,000 tons but as of August first it had risen to 1,180,000 tons, plus oil in amount equal to 185,000 tons additional—or a total of 1,365,000 tons. The most satisfactory aspect of this situation is that the piles are not now being depleted but are still growing, though slowly, during the present season of dry weather and minimum hydro output. The "if" has therefore been reduced to the far less worrisome one of "if we can keep up what we are doing for two months more" and the probability is that we can.

If all this coal could be burned as efficiently as is that used in the most efficient plants of the territory, it would supply more than all the power needed in a year. Unfortunately this cannot be done and on the average the coal consumption is two to three times as great. This situation is fully recognized and is the reason that regardless of ownership the most efficient plants are operated fully loaded and as nearly continuously 24 hours per day as conditions will permit.

Our efforts in this and other lines are under the constant scrutiny of the War Production Board, the officials of which can be of material assistance if a pinch comes. As an authorized means of contact there has been created a New England Committee of Coordination composed of the Presidents of the ten largest power producing companies of the territory.

The great value of the interconnecting lines which crisscross New England lies not, as is commonly supposed in the ability of a territory with surplus power to supply that surplus to a deficient territory—but rather in the complementary nature of the first two causes of possible shortage, lack of generating capacity and insufficient streamflow.

A territory deficient as to peak capacity may well have ample capacity to help out on the 24-hour load of a territory suffering from low water thus conserving any seasonal storage for later use.

The territory with a deficiency from lack of water can, in turn, help the neighboring territory at the time of its inability to carry its peaks through the conservation of its seasonal pondage for the purpose.

Thus two territories, each in itself incapable of carrying its war loads without civilian curtailment can, when connected by transmission lines, so supplement the weakness of each other that curtailment can be avoided.

To summarize, I believe that the far-sighted advance preparation made by our companies to meet war requirements coupled with intelligent integrated operation of all facilities—and supplemented by the cooperation of the War Production Board in the matter of priorities for fuel and other essentials—will carry New England through the coming winter without any curtailment of civilian requirements. However in spite of this probability careful study is being given to the thousand and one details involved in carrying out any rationing of power to the end that curtailment, if it comes, shall be carried out in an orderly manner with the minimum of inconvenience to all.

New EEI Publication

UTILIZATION VOLTAGE STANDARDIZATION RECOMMENDATION

EEI. Pub. J-8. A joint report of the Electrical Equipment Committee and the Transmission and Distribution Committee, Edison Electric Institute, 12 pages. Price 20c to members and their employees; 50c to non-members in the U.S.A.; 60c to foreign countries.

A NEW joint EEI-NEMA Committee on Preferred Voltage Ratings for A-C Systems and Equipment was organized in 1938 to review the 1930 report of a similar joint committee and to make such recommendations and changes as might seem advisable.

For the past four years, the Electrical Equipment Committee and the Transmission & Distribution Committee of the Edison Electric Institute have been actively studying the problem of utilization voltage standards. The need for such standards arises specifically from the multiplicity of service voltages which are in use throughout the industry. This has led to demands for considerable variety in the ratings of utilization equipment and to the fear that the variety may tend to increase unless some steps are taken to establish standard utilization voltage limits.

This report gives the results of the studies by the Electrical Equipment and Transmission and Distribution Committees. It also contains an extensive review of the various considerations leading up to the committees' recommendations. These recommendations have been presented to the Joint EEI-NEMA committee to serve as a basis of further work by the Joint Committee.

The Conservation of Automotive Equipment

By Jean Y. Ray

Virginia Electric and Power Company, Richmond, Va., and Chairman, SAE T & M Activity Committee

A paper presented before the Transmission and Distribution Committee, EEI, Cincinnati, Ohio, Oct. 20, 1942

WHEN Japan conquered Indo-China, British Malaya, and the Netherlands East Indies, it cut off from the rest of the world the source of supply of about 90 per cent of its crude rubber. True, this nation had a stock pile of approximately 700,000 long tons of rubber, for which we should be thankful, but this stock pile is not available for joy-riding and vacations; it is necessary for the conduct of the war—for us and the United Nations—and barely sufficient for those needs. If we face a long war, which seems probable, it is distinctly evident that only the most essential automotive transportation can be maintained for the duration and *that* only by a most rigid system of conservation of tires, which means taking care of the tires which we have now in order that we will have tires two years from now. This is our problem—no more, no less—and if we do not conserve now, we will not have tires two years from now.

Our Government recognized this situation very promptly, and within three weeks of the bombing of Pearl Harbor, tire rationing regulations were issued by the Office of Price Administration. At the outset, these regulations, as far as gas and electric utilities were concerned, limited the vehicles for which new tires and tubes could be obtained to trucks used for the transportation of material and equipment for the construction and maintenance of public utility systems; for the transportation of material and equipment for the construction and maintenance of production facilities and for transportation essential to render repair services.

Certain restrictions were imposed such as the requirements that the applicant must show that the vehicle on which the new tire or tube is to be mounted cannot be replaced by a vehicle owned or operated by or subject to the control of the applicant, which is equipped with serviceable tires and tubes and which is not fully employed. The new tire or tube is to be installed at once on a wheel to replace a tire or tube no longer serviceable. That the new tire or tube, when added to all other tires or tubes of the same size in the applicant's possession, whether or not such tires or tubes are mounted on a vehicle, does not add up to more than one spare tire or tube of a given size for each eligible vehicle. The existing tire cannot be recapped, retreaded, or repaired for safe use.

Under these regulations a vehicle to qualify as an eligible unit must have been originally designed as a truck. A converted passenger car or station wagon was not an eligible vehicle. However, with the institution of truck rationing, coupes and station wagons that had been converted for meter and service work by public utilities were classified as trucks when it was found that utilities were using a large number of these vehicles that would have to be replaced with trucks if the classification was not changed.

In February, the vehicles eligible for new tires and the regulations governing their use were designated as List "A" and a new classification known as List "B" was adopted to provide recapped or retreaded tires for vehicles used in certain operations not covered by List "A".

Vehicles eligible under List "B" included those used for transportation of persons to enable them to render construction or mechanical service or structural repair and maintenance service; for the transportation of executives, engineers, technicians, and workers to and from, or within such of the following as are essential to the war effort: power generation or transmission facilities, transportation facilities or extractive, industrial, military or naval establishments; trucks used for any important purposes not included in List "A". It must be shown that without the vehicle to be equipped, transportation service is not available to applicant. However, it should be borne in mind that no recapped tires are available for vehicles on List "B" until after the requirements of the vehicles on List "A" have been satisfied.

Further changes which became effective June 1, 1942, prohibit rationing boards from granting new tire certificates for use on vehicles on List "A" when the tire in use can be retreaded. Also, no tires at all will be released after June 1, when it appears that the old tire failed or wore out prematurely because of abuse caused by overloading, underinflation, or careless operation.

It is now apparent that more stringent regulations in the form of Limitation Orders will be issued within the next few months and that many probable uses now considered eligible will be classed as ineligible.

There are about 35,000,000 motor vehicles in operation in the United States, including about 5,000,000 trucks, whereas the tire stock pile available for rationing contains only about 6,000,000 tires. Many sizes of tires are not now being manufactured and most of the vehicles in public utility fleets are, unfortunately, equipped with tires in the sizes which are no longer in production, so that those now on hand on the vehicles and in the stock pile must last us for the duration, or until substitutes are available, "or else."

The tire rationing regulations, as they now stand, require the utility companies to curtail, and in some cases to eliminate, certain operations and services requiring the use of motor vehicles. Most of the utility companies have already taken steps toward this end and, to a large extent, the use of passenger automobiles have been completely eliminated already. In our Company, for example, passenger car mileage for the first eight months of 1942 is 55 per cent less than for the same period in 1941. But, we didn't wake up soon enough after Pearl Harbor either—since, for the past five months, April to August, the reduction is 71 per cent. Other companies have done even better.

The attitude of the officials of OPA toward the problem of public utility fleet operators has been sympathetic and public utilities, as a whole, are undoubtedly recognized as essential war industries. However, regardless of how essential any industry or an operation may be, the rationing authorities point out that the rubber situation is simply desperate—that is all there is to it—and it is, there-

fore, going to be necessary to eliminate all use not essential to the war effort and many operations which have up to now been considered essential.

You can easily determine from publicity you have seen in the daily press that the attitude of the Government officials as regards tire rationing is, that if the operation of the vehicle is not definitely essential in the war effort or to public health and safety, it should be eliminated. What are the public utility operations which are not considered essential and which the authorities think should be discontinued and for which, therefore, no new tires or recaps will be issued? We have in the past considered the following list of operations very essential, but we will have to do without them in the future. Here they are, in part:

Sales supervision.

Home cooking and lighting demonstrations.

Delivery and pickup of appliances.

Power and industrial engineering, except in connection with direct war activity and then only when public transportation is not available within half a mile.

Responding to general complaints from customers which do not involve an eligible maintenance or repair service.

Meter reading. The Assistant General Counsel of OPA has this to say about meter reading:

> "The problem of meter reading has been given serious consideration and it is fully appreciated that some sacrifices in the speed with which such operations have previously been carried out will have to be made. However, the grave shortage of rubber that faces our Nation at this time is so acute that some of even the most vital needs will go unsupplied. Inasmuch as meter reading does not involve any construction, maintenance, or repair service, it is impossible to find eligibility for such service under the Regulations."

Many companies are now reading meters at three-month intervals for certain classes of service, and it is expected that this practice will be approved in a Limitation Order on use of motor vehicles by public utilities which is now under consideration. Many other companies are making wide use of bicycles and public transportation. Certainly a large percentage of meters can be reached by these means.

Collections.

Delivery of bills.

High bill complaints.

Delivering checks to employees or pensioners.

Trips by executives and supervisors between company offices where public transportation is available.

Safety activity for construction and inspection. Protective equipment can be transported for replacement and repair.

Inspection of property for insurance purposes.

All Claim Department activity.

All Legal Department use.

Engineering—except when directly connected with construction, maintenance, and repair projects. No inspections.

Transportation of employees for the purpose of securing rights-of-way or contacting owners of overhanging trees.

Service of minor and portable appliances. All except large fixed appliances such as ranges, refrigerators, water heaters, furnaces, etc.

Periodic meter testing as required by State agencies.

All incidental services which do not relate to maintenance or construction.

Vehicles must be used 100 per cent for eligible purposes in order to obtain tire certificates. Any ineligible use, no matter how small the percentage, bars the vehicle from being eligible for tires or tubes.

As yet no definite instructions have been issued with regard to Customers' Service Calls, but it is felt that the utilities can make a further substantial saving of rubber through extending the time period from the present practice of giving sudden service to anywhere from four to 24-hour periods so as to permit more economical routing of calls and eliminate doubling back over routes. They have definitely suggested that the service men use public transportation when and where it is available, carrying their tools and fuses in a small kit such as is used by telephone repair men in urban centers. They point out that "business as usual" is out for the duration and that it is far more important at this time to save rubber than to give sudden service to civilian or non-essential trouble calls.

There are now approximately 16 limitation orders and directives issued by various government agencies in the interest of the conservation of vehicles, parts, gasoline, and tires that affect the operation of motor vehicles. All but four of these have a more or less direct bearing on the operation of public utility automotive equipment, car, truck, and bus.

The WPB has ordered manufacturers to discontinue making passenger cars and trucks for civilian use for the duration. This was followed by car and truck rationing which eliminated the sale of vehicles for replacement purposes and making it next to impossible to purchase additional equipment. Another WPB order discontinues the manufacture of certain non-functional automotive parts and limits the number of functional parts that can be manufactured. This order also requires the operator to turn in for salvage all old parts replaced with new ones.

The gasoline rationing regulations which became effective in July require operators of motor vehicles to describe the use made of all vehicles for which truck or supplemental gasoline rations are requested. So far ration boards have taken a very liberal attitude toward utility companies in granting these requests, the only restrictions being that use in connection with sales activities is not considered preferred mileage and no supplemental gasoline ration will be granted.

Early in the year an executive order directed the Office of Defense Transportation to assume control over all rubber borne transportation with authority to determine policies with regard to operation and rationing of vehicles, parts, tires, and gasoline although the agencies then handling the rationing were to continue along lines set forth by the ODT.

Among the limiting orders governing the use of motor vehicles issued by the ODT the following apply to public utility fleets:

General Order No. 17 requires all private carriers to reduce the mileage operated by each group of vehicles by 25 per cent per month as compared with the same month in 1941. In public utility fleets this applies to all vehicles except those used in connection with actual construction, maintenance, or repair service where men and materials are transported.

General Order No. 23 requires all vehicle operators to reduce speeds to not more than the limit set by local authority or 35 miles per hour, whichever is less.

The most recent order affecting commercial motor vehicle operation, this time from the Office of Defense Transportation, is General Order No. 21, which requires that on and after November 15, 1942, all affected vehicles may operate only under Certificates of War Necessity to be issued for each vehicle operated. These certificates will stipulate maximum mileage and maximum or minimum loads of individual vehicles. Without the certificate, no operator will be able to obtain gasoline, tires, or repair parts. These Certificates of War Necessity will be issued through local ODT offices. They will contain stipulations regarding the operation of each vehicle to insure that it is used (1) for opera-

(*Continued on page* 370)

Supplying Kilovar Loads for War Conservation and Economy

By M. C. Miller
Ebasco Services Incorporated

A paper presented at Joint Meeting of EEI Electrical Equipment and Transmission and Distribution Committees, Cincinnati, Oct. 19, 1942

THE PURPOSE of this paper is to present the results of a study made on effects of reactive loads on system loading, voltage drop, voltage regulation and system investment, in two parts:

(1) Effects on system loads and on voltage drop and voltage regulation, and
(2) Investment required to supply kilowatts and kilovars.

The first part of the study brought out many interesting factors and, without waiting to complete the second part, charts and data were prepared in report form for purposes of discussion and possible early application of results. This report necessarily was somewhat technical and difficult to digest; therefore, as opportunities arose, round-table discussions were held with engineering, operating and production department engineers, rate and sales engineers, and executives where practicable. The objective was to promote a better understanding of power factor and reactive loads, as a means of:

Determining what can be done to supply these reactive loads most economically or to reduce them or mitigate their growth, and

Analyzing relationship of transformer and line design characteristics to system reactive loads.

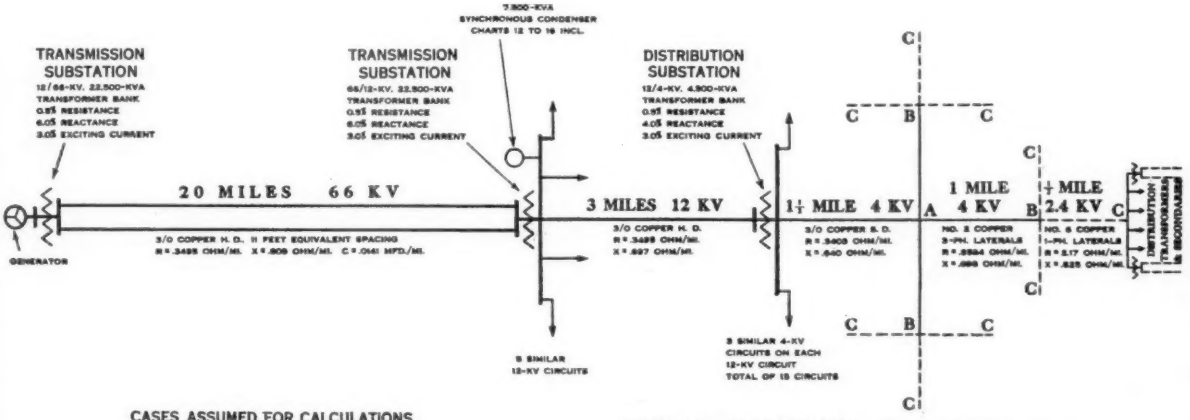
Of greatest importance in this emergency period is to visualize the full effects of reactive loads on system loading, voltage drop and voltage regulation for therein lies the knowledge essential to obtaining the maximum kilowatt carrying capacity on any system and the lowest overall cost of supplying reactive power.

Discussion of Term "Power Factor"

Regarding this "bug-a-boo" of "power factor"—much confusion still exists in the general application of the term "power factor" as the relation of the actual power to the measured volts x amperes, or kilovolt-amperes. Most customers and many non-technical utilities' employees do not understand what "power factor" is all about. To say that a customer has 85 per cent power factor does not indicate to them the fact that the customer requires two-thirds as much reactive power (for magnetizing transformers and motors) as he requires kilowatts of actual power. There seems to be a feeling that a customer who has .85 power factor has a satisfactory and normal condition.

It is believed that a better approach generally to this power factor problem, for contacts with customers, as well as for electric system design calculations, would be in terms of the two fundamental components of electrical loads—"kilowatts" and "kilovars"—*kilowatts* being the actual power and *kilovars* the reactive component or the magnetizing current. Kilovolt-amperes, of course, is the resultant of these two components, or the total load.

To many engineers this approach is not new. Kilowatts and kilovars have been used extensively in power circuit studies especially those made on the network analyzer. There seems to be a



CASES ASSUMED FOR CALCULATIONS

KVAR OF CAPACITORS ON EACH OF 15 CIRCUITS					TOTAL
CASE NUMBER	AT "C" (19)	AT "B" (13)	AT "A" (11)	TOTAL PER CIRCUIT	On 15 CIRCUITS
1	0	0	0	0	0
2	15	0	0	135	2025
3	15	45	0	270	4050
4	15	90	0	405	6075
5	15	90	135	540	8100
6	15	90	300	705	10575
7	*	0	0	0	0

* LOADS AT POINTS "C" ASSUMED TO BE UNITY POWER FACTOR AT BOTH PEAK AND LIGHT LOADS

BASE LOAD AT EACH POINT "C" (LOAD CENTER OF SINGLE-PH. LATERALS)
AT TIME OF PEAK LOAD - 100 KW. 75 KVAR. 125 KVA AT 80% POWER FACTOR
AT TIME OF LIGHT LOAD - 20 KW. 30 KVAR. 36 KVA AT 55.5% POWER FACTOR

TOTAL LOAD AT POINTS "C" FOR 15 CIRCUITS
AT TIME OF PEAK LOAD - 13,500 KW. 10,125 KVAR. 16,875 KVA AT 80% POWER FACTOR
AT TIME OF LIGHT LOAD - 2,700 KW. 4,050 KVAR. 4,866 KVA AT 55.5% POWER FACTOR

BASE LOAD ON EACH 240-V. SECONDARY LINE
AT TIME OF PEAK LOAD - 7.83 KW. 5.88 KVAR. 9.67 KVA AT 80.9% POWER FACTOR
AT TIME OF LIGHT LOAD - 1.96 KW. 2.28 KVAR. 2.79 KVA AT 57.01 POWER FACTOR

TOTAL LOAD ON SECONDARIES
AT TIME OF PEAK LOAD - 13,683 KW. 9,208 KVAR. 13,670 KVA AT 80.9% POWER FACTOR
AT TIME OF LIGHT LOAD - 2,578 KW. 3,707 KVAR. 4,588 KVA AT 57.01 POWER FACTOR

Chart 1—Diagram showing Assumed System and Loads Also Locations and Kvar of Capacitors Installed for Study of Effects of Kilovar Loads.

growing trend toward more general use of these terms with only incidental mention of power factor. Generally, distribution system loads have been measured in amperes, and calculations have been based on kilovolt-amperes. Frequently, kilovar loads on distribution circuits are not known, nor are meters provided for kilovar measurements.

The concept of two components, kilowatts and kilovars, is fundamentally sound. Separate determination of the effects of these two components simplifies and clarifies many design calculations. One of the hopes of this paper is to foster this use.

Brief Explanation of Study and Charts

Chart No. 1

The specimen system shown on Chart No. 1, was used as a basis for this study. Briefly, it comprises a generator, step-up transformer to 66-kv transmission line, step-down transformer to five 12-kv circuits, each serving a 12-kv/4-kv substation with three 4-kv distribution circuits. The line and transformer characteristics are shown on this chart.

Chart No. 2

Throughout this study, the two components of loads, kilowatts and kilovars, and the resultant load in kilovolt-amperes have been determined for peak-load conditions and for light-load conditions, for each section throughout the system—step by step from the customers' service back to the generator. In this way, effects of kilovars are determined for the conditions and loads assumed.

Case (1). With a load of 12,700 kw and 9,200 kvar applied at the load center of the secondaries, this kilowatt load continues to grow back toward the generator because of the I^2R losses due to the total kilovolt-ampere load. On this system the customers' load, plus the losses, result in a total generator load of 16,500 kw. The total losses amount to about 3,800 kw at time of peak load or, the losses are 23 per cent of the total net generated. The kilowatt losses are shown to a larger scale on Chart No. 3.

The growth of the kilovar load is quite a surprise. The reactive component of 9,200 kvar (coincident with the 12,700 kw) almost doubles by the time it gets back to the generator. This exceedingly rapid kilovar growth, (or it might be termed a kilovar, or I^2X loss) is due to the total kilovolt-ampere load current flowing through reactance

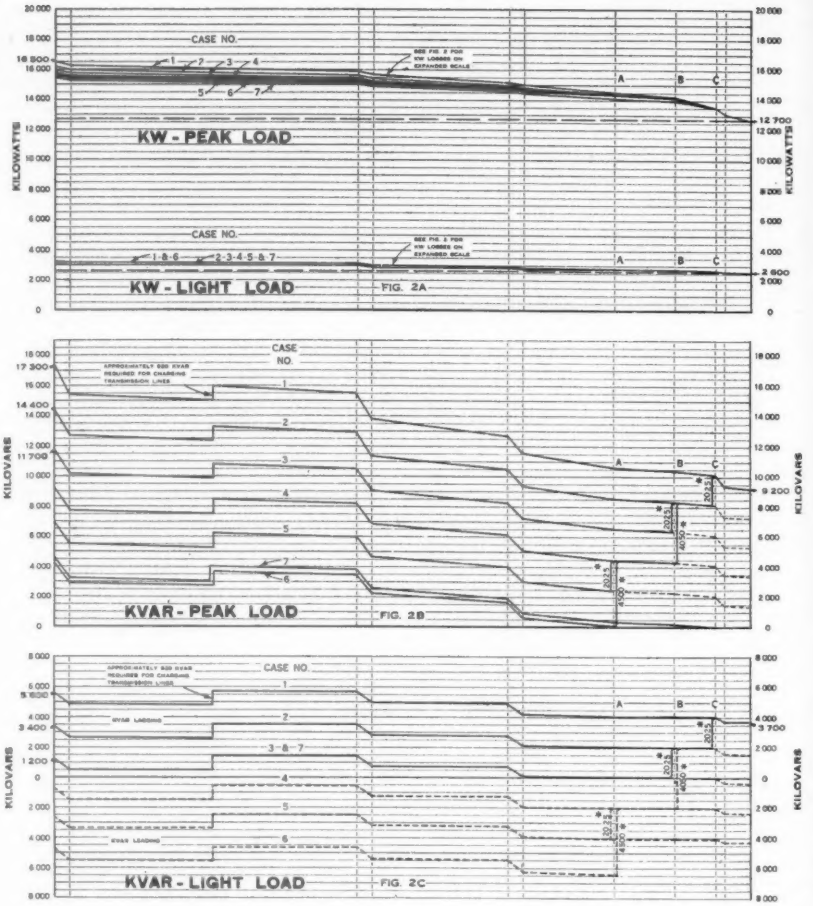


Chart 2—Kw, Kvar and Kva Loads in Each Section of System and Reductions in Loads Resulting from Capacitor Installations.

of lines, transformers and other equipment and the magnetizing current required by transformers, regulators, etc. We call this the "snowball" effect of kilovar loads.

The growth of the kilovolt-ampere loads is quite surprising also. With a total customers' load of 15,700 kva, and the growth in kilowatt load and the "snowball" growth in kilovar load, this kilovolt-ampere load is increased by 50 per cent by the time it gets to the generator, resulting in a 23,900-kva load to supply a customers' kilowatt load of 12,700. This kilovar load then, not only increases the size of the distribution transformers required, but also increases the size of the transformers at the 4-kv and 12-kv substations, and at generating station. For these four transformations, the aggregate duty is 78,500 kva to supply 12,700 kw to the customers. This factor frequently may be overloooked.

With the loads assumed, the resulting loads on the generator, 16,500 kw and 17,300 kvar, might materially limit the permissible kilowatt output of the generator. It is surprising how frequently this condition is encountered. Many thousands of kilowatts of capacity in generators may be made available by reducing or otherwise generating kilovars.

To show to what extent the customers' 9,200-kvar load increases losses and growth of loads throughout the system, peak load conditions were assumed having the same kilowatt load but no kilovar load (at load center of single-phase laterals at points marked "C") as Case No. 7. This results in reducing the kilovolt-ampere load at these locations by approximately 3,300 kva, and because of the reduced kilovolt-ampere loads throughout the system, the kilowatt losses at time of peak are reduced materially. In this particular case, the peak losses are decreased by about 1,100 kw, and the kilovolt-ampere load on the generator is decreased by approximately 7,900 kva. In other words, this 9,200-kvar load results in increasing the load on the generator by 1,100 kw, 12,700 kvar and 7,900 kva; also, increases the aggregate duty in the four transformations from 58,500 to 78,500 kva. Generally, it is not thought of as being necessary to provide prime mover capacity because of generating kilovars—but in this case 1,100 kilowatts in the prime mover is required to supply customers with 9,200 kvar.

To learn the comparative effects of generating kilovars close to locations where required, that is close to customer loads, as compared to generating at the power station and transmitting over the system—this study was continued to show the loads throughout the system if kilovars are generated by capacitors installed as close to the load as practicable.

Case No. 2 shows the reduced loads throughout the system, with the same customer kilowatt and kilovar loads, but with a 15-kvar capacitor installed at the load center of each single-phase lateral at points marked "C," a total of 2,025 kvar. At this location, the kilovar load is reduced by 2,025 kvar and the kilovolt-ampere load is reduced from 17,000 to 16,000 kva. Because of the reduced kilovolt-ampere load, the I^2R loss at time of peak is reduced from 3,800 to 3,450—or 350 kw (see Chart No. 3); also, the I^2X build-up is considerably less, with the result that the kilovolt-ampere load throughout the system is reduced.*

It is important to note the cumulative effect of these 2,025 kvar of capacitors installed close to customers' loads. Because of these cumulative effects, the kilovar load on the generator is reduced by approximately 3,000 kvar. Stated another way, with the station generator overloaded by kilovars, installing 2,025 kvar of capacitors on the bus reduces the load on the generators by 2,025 kvar; however, with this same amount of capacitors installed on distribution circuits as described, the reduction of load on the generators is 3,000 kvar. Likewise, at an intermediate substation, the reduction is greater than the kvar of capacitors installed.

To carry this study through and determine the effects of additional capacitors, it was assumed that successive installations are made until unity power factor is obtained on the distribution circuits at time of peak loads. The step-by-step effects of these are shown by Cases No. 3 to 6, inclusive. The effect of each installation is progressively less as unity power factor is approached. Practically, it may be only in rare cases that the last one or more of these increments would be economically justified. However, cases are not rare where prime movers have sufficient capacity for generators to deliver kilowatts up to full kilovolt-ampere rating.

There are limitations to the use of capacitors planned to obtain maximum benefits at time of peak loads. As long as connected, capacitors put out kilovars whether or not these kilovars are required; therefore it is necessary to determine the effects during light-load periods. These conditions, for this assumed system are indicated on Charts No. 1 to 5 inclusive. With peak-loads as assumed, minimum loads are in the order of 2,600 kw and 3,700 kvar—(a power factor of 57 per cent). The first two groups of capacitors provide just about the right amount to furnish the kilovars required by customers at time of light load and still leave a slightly lagging load on the generator. However, further installations of capacitors on this system result in the kilovars which these put out, flowing backward through the system toward the generator, probably causing increased kilovolt-ampere loading and losses in that part of the system, also perhaps creating leading power factor in the generator with instability problems. Where such conditions are encountered, as might be the case if long transmission lines were added, these further installations still may be economical, even though necessary to install automatic control switching to disconnect capacitors during light-load periods.

It should be noted that these same benefits at the time of peak loads from capacitor installations will be obtained if instead, by some means, customers' requirements for kilovars are equivalently reduced. If customer installs capacitors at his main-line switch and operates these 24 hours a day, which is usual, effects beneficial at time of peak loads may become harmful during light loads. Such customer installations of capacitors might expand to a degree where it becomes necessary to install automatic switching for capacitors on the utility lines. Three items of actual experience may not be out of place for illustration:

Extensive use of capacitors by customers perhaps might be on the basis of such capacitors being controlled with the load—connected at the motor terminals and switched on and off with the load. Possibly this requirement could be included in utility rules and regulations, especially where power-factor type of rate is in effect.

Another and better way to reduce

* Notwithstanding that kilovar is now the American Standard term for reactive power, synchronous condensers and capacitors still are rated in kilovolt-amperes, although both are generators of kilovars only. In this paper, for consistency and to avoid confusion, these ratings are expressed in kilovars.

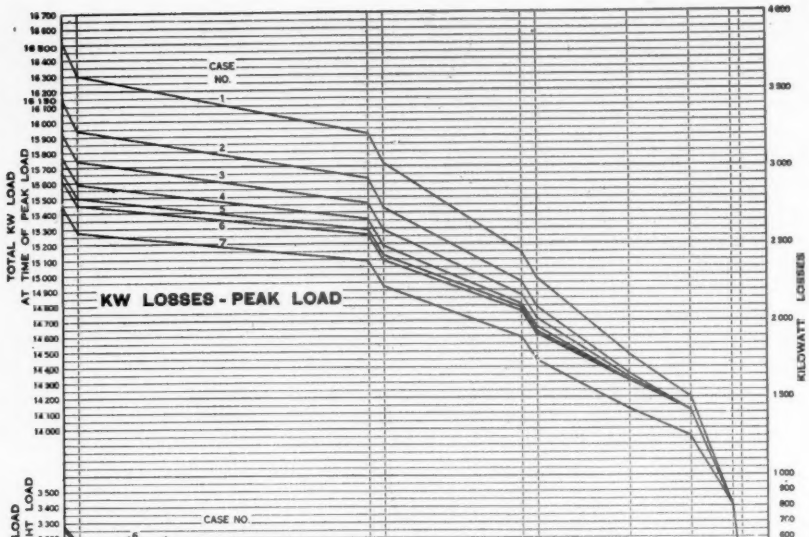

CASE NO.
KW LOSSES - PEAK LOAD
TOTAL KW LOAD AT TIME OF PEAK LOAD
KILOWATT LOSSES
CASE NO.
KW LOSSES - LIGHT LOAD
TOTAL KW LOAD AT TIME OF LIGHT LOAD
20 MILES 66 KV
3 MILES 12 KV
1½ MILE 4 KV
1 MILE 4 KV
½ MILE 2.4 KV
SEE CHART 1 FOR DETAILS OF SYSTEM LOADS AND LOCATION AND SIZE OF CAPACITORS

Chart 3—Total Kilowatt Losses in System and Reductions in Losses Resulting from Capacitor Installations.

customers' requirements for kilovars is the proper loading of motors, which usually results in reduced kilovar demands without the detrimental effects from uncontrolled capacitors. In the present emergency, sales engineers are aiding by working with customers to gain the advantages of properly loaded motors.

Chart No. 3

This chart shows the kilowatt losses at peak load and at light load, the same as on Chart No. 2, Cases 1 to 7 inclusive, except to a larger scale.

Chart No. 4

The preceding charts show the effects of kilovars on system loads and losses. Charts Nos. 4 and 5 show the effects on voltage drop and voltage regulation. Before briefly explaining these charts, it may be helpful to mention a fundamental of the method of calculating voltage drop. The usual formula for calculating drop in volts or in per cent, when analyzed, is found to be *voltage drop due to the kilowatt component of the load* plus *voltage drop due to the kilovar component of the load.* The voltage drop due to kilowatts, simply stated is: the kilowatt load in amperes times the resistance of the circuit. The voltage drop due to kilovars is: the kilovar load in amperes times the reactance of the circuit; and the sum of the two is the total voltage drop. In determining the effects of capacitors, this simplification of voltage drop calculation is quite helpful as it gives a much clearer conception of voltage changes which result from such installations.

Chart No. 4 shows the voltage drop for the same system and loads shown on Charts 1 and 2. At the time of peak load with 12,700 kw and 9,200 kvar delivered to customers, the total voltage drop in per cent is shown for each part of the system, which (accumulated) total 35 per cent. With this load at unity power factor (Case 7) the voltage drop (which is the voltage drop due to the kilowatt load) is 20 per cent, the other 15 per cent is due to the kilovar load.

With this same kilowatt and kilovar load, and capacitors as previously indicated, the voltage drop *due to the kilovar load* is decreased and when sufficient capacitors are installed to reach unity power factor, all of the drop due to kilovars is eliminated.

At time of light load, the total voltage drop for the loads assumed is 11 per cent—5 per cent due to kilowatt loads

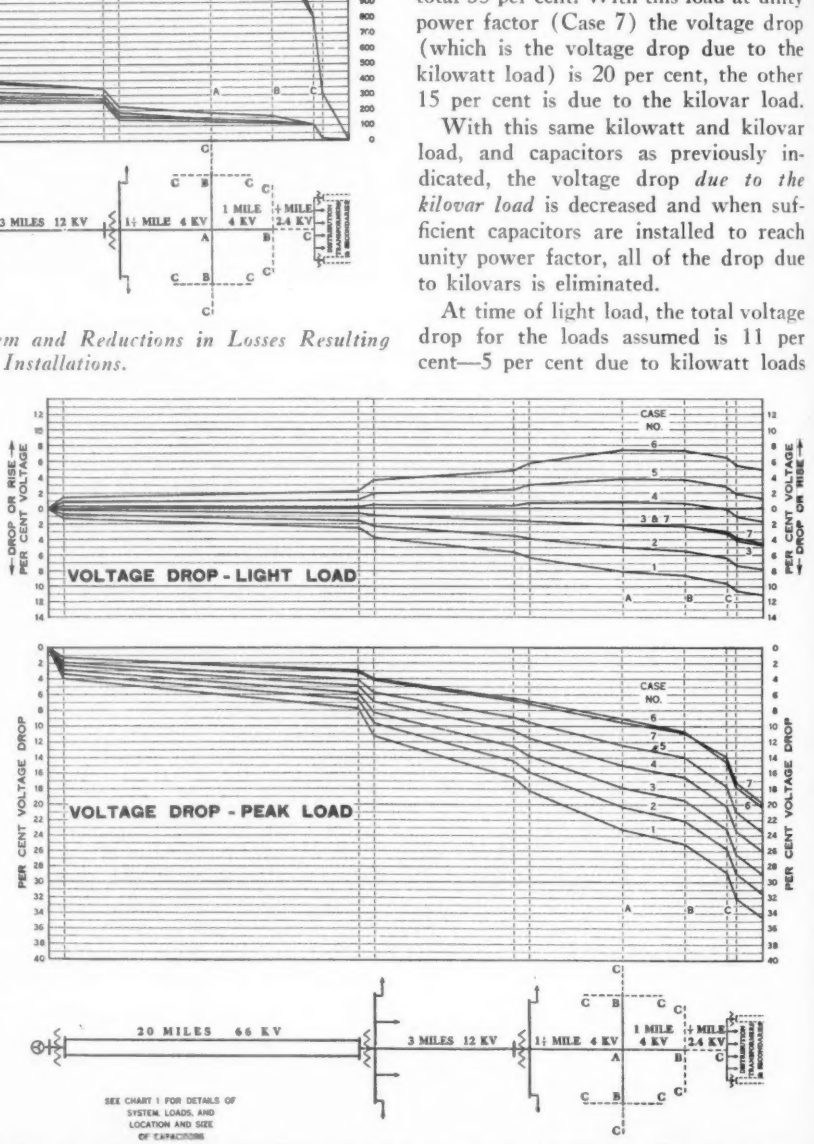

CASE NO.
DROP OR RISE — PER CENT VOLTAGE
VOLTAGE DROP - LIGHT LOAD
PER CENT VOLTAGE — DROP OR RISE
CASE NO.
PER CENT VOLTAGE DROP
VOLTAGE DROP - PEAK LOAD
PER CENT VOLTAGE DROP
20 MILES 66 KV
3 MILES 12 KV
1½ MILE 4 KV
1 MILE 4 KV
½ MILE 2.4 KV
SEE CHART 1 FOR DETAILS OF SYSTEM LOADS AND LOCATION AND SIZE OF CAPACITORS

Chart 4—Percent Voltage Drop in Each Section of System and Rise in Voltage Level Resulting from Capacitor Installations.

and 6 per cent due to kilovar loads. The first two installations of capacitors eliminate the 6 per cent voltage drop due to kilovar load, and further installations first neutralize the voltage drop due to kilowatt load and then cause a voltage rise as indicated.

Note that the voltage change caused by adding a group of capacitors is approximately the same regardless of the value of the load, i.e. the change is the same at peak load as at light load. Capacitors continuously operated serve to lift the voltage level but do not change the voltage regulation.

Chart No. 5

Voltage drop is one thing, and while quite serious, frequently may be remedied by changing transformer taps. Voltage regulation is something else, and usually requires varying of generator bus and transmission system voltage, tap changing transformers, regulators, or other control measures to improve conditions when the voltage range gets beyond allowable limits. In this case, with the voltage drop of 35 per cent at time of peak load and 11 per cent at time of light load, the voltage regulation is 24 per cent. If, at peak load and light load, there is no kilovar component in the load, the regulation is 15 per cent. Therefore, approximately one-third of the total regulation is caused by the variation in kilovar loads.

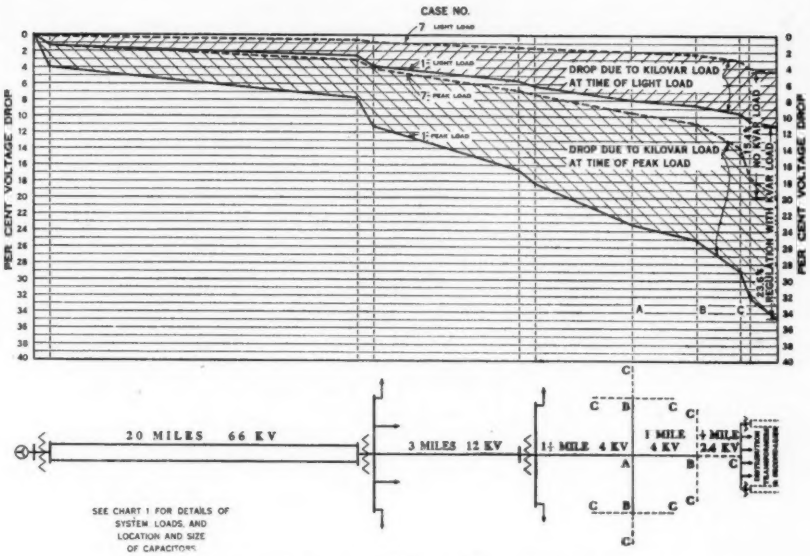

CASE NO.
7 LIGHT LOAD
1½ LIGHT LOAD
7 PEAK LOAD
1 PEAK LOAD
DROP DUE TO KILOVAR LOAD AT TIME OF LIGHT LOAD
DROP DUE TO KILOVAR LOAD AT TIME OF PEAK LOAD
PER CENT VOLTAGE DROP
20 MILES 66 KV
3 MILES 12 KV
1½ MILE 4 KV
1 MILE 4 KV
½ MILE 2.4 KV
SEE CHART 1 FOR DETAILS OF SYSTEM LOADS AND LOCATION AND SIZE OF CAPACITORS

Chart 5—Comparison of Voltage Drop and Regulation

Weighing Design Features

Referring back to Chart No. 2; the statement that the kilovar loads have a definite "snowball" effect and practically double from the customer to the generator at time of peak load, fails to emphasize the fact that this increase from 9,200 to 17,300 is the kilovar load taken by the system. This increase of 8,100 in kilovar load (or it may be called a kilovar loss) is made up of magnetizing current required by transformers, regulators, etc., and the I^2X due to load flow through lines and transformers.

It seems quite apparent that the rapid growth in kilovar loads and the cost of supplying these kilovars, calls for careful study and weighing of such factors as magnetizing current required by transformers and regulators, and reactance of lines and transformers. Take as an example a 10,000-kva transformer bank. The magnetizing current may be 3 per cent or 300 kvar, and the reactance may be 6 per cent, resulting in an I^2X loss of 600 kvar at full load—or a total of 900 kvar. An approximate way of evaluating this loss would be to assume the providing of 900 kvar of capacitors at a cost of about $10.00 per kvar to furnish this magnetizing current and I^2X loss.

Frequently, in considering equipment installations for a substation, high-reactance transformers or external reactors are employed to reduce short-circuit duty on circuit breakers. A thorough study of the increased system needs for taking care of the resulting kilovar load and voltage drop and voltage regulation might show it to be more economical in lieu of this high reactance, and in some cases with improved operating conditions, to install breakers having sufficient interrupting capacity.

Prevailing distribution transformers generally have high reactance, and in numerous cases larger transformers have to be installed because of excessive voltage regulation, largely due to the kilovar component of the load and the high transformer reactance. The I^2X loss is high because of this high reactance and loading transformers to the thermal limits. It may be that these transformer characteristics should be investigated, and perhaps when the effect of increased voltage regulation and kilovar loss is evaluated, transformers for better overall economy can be built.

This study indicates the desirability for thoughtful reappraising of certain features of system and equipment design—all the way from the customer service to the generator.

Increasing System Kilowatt Capacity

From the foregoing charts and discussion, it is apparent that on systems where kilovar loads are relatively large and mostly generated at the power station and transmitted over long distances, there is a probability of gaining considerable system kilowatt capacity by generating kilovars close to the loads. During the past five years, since the development of the pole-type capacitors, somewhere in the order of two to three million kvar have been installed by utilities. A large percentage of these have been installed in small groups on distribution circuits; however, many large installations have been made at substations, some of these exceeding 20,000 kvar. At the present time, not only are capacitors an economical means of generating kilovars, but they are among the few means left for gaining capacity quickly and at a low cost. It is believed that on very few systems have the optimum use of capacitors been reached. Also, it is predicted that reduction in kilowatt losses at time of peak, alone, could release hundreds of thousands of kilowatts of generating capacity on utility systems in this country.

Capacitors versus Synchronous Condensers

This paper does not discuss the comparative effects of capacitors installed close to loads and synchronous condensers at substations, although these were studied.

Synchronous condensers may have advantages where large units are practical and large blocks of kilovars are required. They provide both leading and lagging kilovars, and automatic voltage regulation. However, the kilowatt loss-

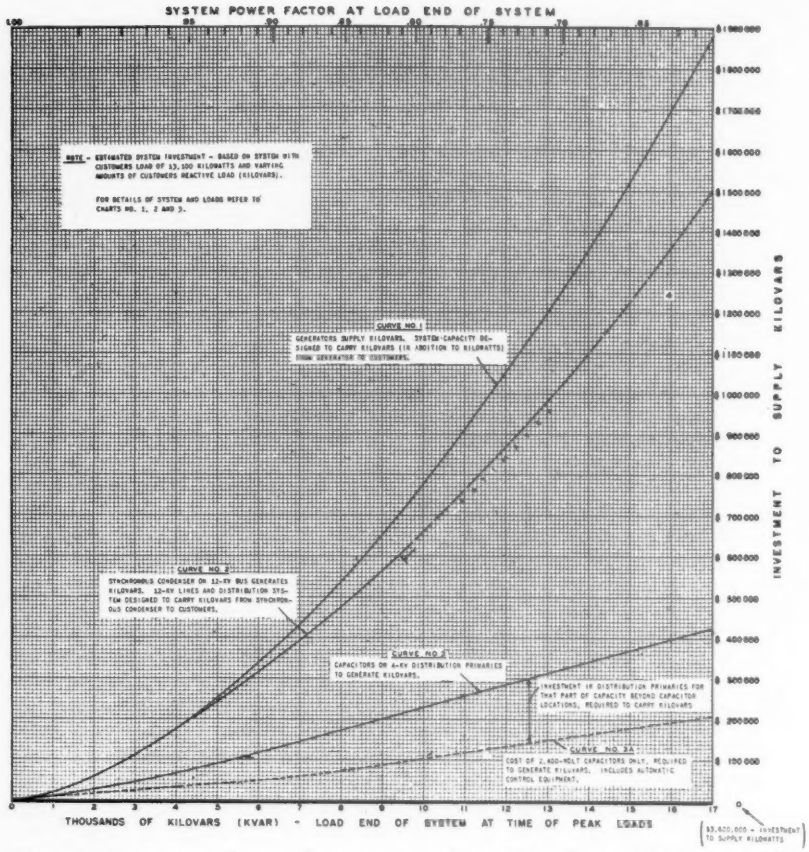

SYSTEM POWER FACTOR AT LOAD END OF SYSTEM
NOTE - ESTIMATED SYSTEM INVESTMENT - BASED ON SYSTEM WITH CUSTOMERS LOAD OF 13,100 KILOWATTS AND VARYING AMOUNTS OF CUSTOMERS REACTIVE LOAD (KILOVARS).
FOR DETAILS OF SYSTEM AND LOADS REFER TO CHARTS NO. 1, 2 AND 3.
CURVE NO. 1
GENERATORS SUPPLY KILOVARS. SYSTEM CAPACITY DESIGNED TO CARRY KILOVARS (IN ADDITION TO KILOWATTS) FROM GENERATOR TO CUSTOMERS.
CURVE NO. 2
SYNCHRONOUS CONDENSER ON 12-KV BUS GENERATES KILOVARS. 12-KV LINES AND DISTRIBUTION SYSTEM DESIGNED TO CARRY KILOVARS FROM SYNCHRONOUS CONDENSER TO CUSTOMERS.
CURVE NO. 3
CAPACITORS ON 4-KV DISTRIBUTION PRIMARIES TO GENERATE KILOVARS.
INVESTMENT IN DISTRIBUTION PRIMARIES FOR THAT PART OF CAPACITY BEYOND CAPACITOR LOCATIONS, REQUIRED TO CARRY KILOVARS
CURVE NO. 3A
COST OF 2,400-VOLT CAPACITORS ONLY, REQUIRED TO GENERATE KILOVARS. INCLUDES AUTOMATIC CONTROL EQUIPMENT.
INVESTMENT TO SUPPLY KILOVARS
THOUSANDS OF KILOVARS (KVAR) - LOAD END OF SYSTEM AT TIME OF PEAK LOADS
($3,600,000 = INVESTMENT TO SUPPLY KILOWATTS)

Chart 6—Division of System Investment to Show That Part of Investment Allocated to Generation and Supply of Kilovars.

for kilovars is indicated by Curve No. 3. Note that in the first case with low-power-factor loads, as much as 25 per cent of the total system investment is required to generate and supply kilovars. With the optimum use of capacitors, this is reduced to about 7 per cent of the total investment.

Chart No. 7

Chart No. 7 shows these estimated investments replotted to be somewhat more indicative of the investment required to generate and supply kilovars on a specific system, when taking into consideration the two major factors:

(1) The method of generating and supplying kilovars, and
(2) The extent of kilovar load in relation to kilowatt loads.

Curve No. 1 shows the investment per kilovar for various ratios of kilovar to kilowatt loads when the kilovars are generated at the power station. Note that this investment increases as the ratio increases and may be as high as $80 per kilovar where the power factor at the load end of the system is around 75 per cent. With the optimum use of capacitors, the investment as indicated by Curve No. 3 is around $25 per kilovar, and the curve tends to flatten out—even with extremely low-power-factor loads. Note that this $25 per kilovar

(*Continued on page* 392)

es are high as compared to capacitor losses.

Capacitors are more economical for installation close to domestic, commercial, and the average industrial loads. There is no intention to imply that synchronous condensers do not have a definite place on electric power systems.

System Investment

Chart No. 6

This chart indicates approximately the proportion of the system investment which is required to generate and supply kilovars. It is based on the same assumed system and loads previously discussed. With the load kilowatts only (unity power factor), the estimated total investment for the system in $3,600,000, on $275 per kilowatt of load.

The system investment is increased for various incremental steps of kilovar loads added to this kilowatt load. With the kilovars generated at the power station, the part of the system investment required to generate and supply kilovars is indicated by Curve No. 1. With the kilovars generated by capacitors strategically located, the system investment

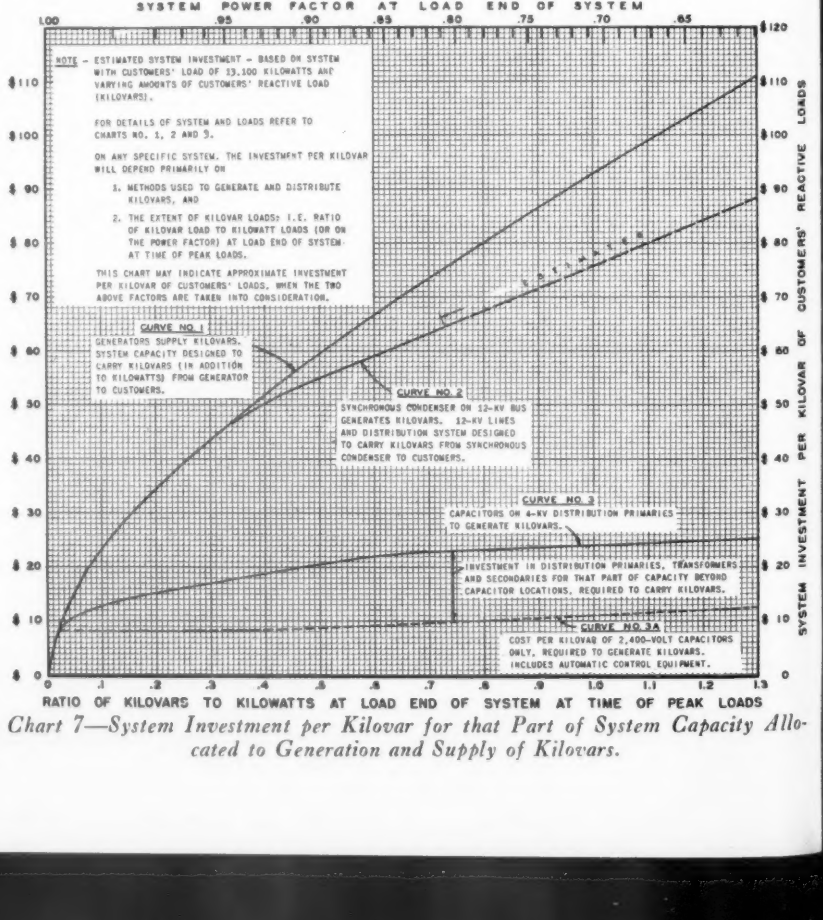

SYSTEM POWER FACTOR AT LOAD END OF SYSTEM
NOTE - ESTIMATED SYSTEM INVESTMENT - BASED ON SYSTEM WITH CUSTOMERS' LOAD OF 13,100 KILOWATTS AND VARYING AMOUNTS OF CUSTOMERS' REACTIVE LOAD (KILOVARS).
FOR DETAILS OF SYSTEM AND LOADS REFER TO CHARTS NO. 1, 2 AND 3.
ON ANY SPECIFIC SYSTEM, THE INVESTMENT PER KILOVAR WILL DEPEND PRIMARILY ON
1. METHODS USED TO GENERATE AND DISTRIBUTE KILOVARS, AND
2. THE EXTENT OF KILOVAR LOADS: I.E. RATIO OF KILOVAR LOAD TO KILOWATT LOADS (OR ON THE POWER FACTOR) AT LOAD END OF SYSTEM AT TIME OF PEAK LOADS.
THIS CHART MAY INDICATE APPROXIMATE INVESTMENT PER KILOVAR OF CUSTOMERS' LOADS, WHEN THE TWO ABOVE FACTORS ARE TAKEN INTO CONSIDERATION.
CURVE NO. 1
GENERATORS SUPPLY KILOVARS. SYSTEM CAPACITY DESIGNED TO CARRY KILOVARS (IN ADDITION TO KILOWATTS) FROM GENERATOR TO CUSTOMERS.
CURVE NO. 2
SYNCHRONOUS CONDENSER ON 12-KV BUS GENERATES KILOVARS. 12-KV LINES AND DISTRIBUTION SYSTEM DESIGNED TO CARRY KILOVARS FROM SYNCHRONOUS CONDENSER TO CUSTOMERS.
CURVE NO. 3
CAPACITORS ON 4-KV DISTRIBUTION PRIMARIES TO GENERATE KILOVARS.
INVESTMENT IN DISTRIBUTION PRIMARIES, TRANSFORMERS AND SECONDARIES FOR THAT PART OF CAPACITY BEYOND CAPACITOR LOCATIONS, REQUIRED TO CARRY KILOVARS.
CURVE NO. 3A
COST PER KILOVAR OF 2,400-VOLT CAPACITORS ONLY, REQUIRED TO GENERATE KILOVARS. INCLUDES AUTOMATIC CONTROL EQUIPMENT.
SYSTEM INVESTMENT PER KILOVAR OF CUSTOMERS' REACTIVE LOADS
RATIO OF KILOVARS TO KILOWATTS AT LOAD END OF SYSTEM AT TIME OF PEAK LOADS

Chart 7—System Investment per Kilovar for that Part of System Capacity Allocated to Generation and Supply of Kilovars.

The Dim Out

By Alexander Maxwell
Director of Engineering, Edison Electric Institute

DURING the early stages of experiments with blackouts the expression "dim-out" was occasionally used in a rather loose sense for any measure of reduced illumination intended to soften the rigors of the uncompromising blackout. None of these compromise measures appeared to impress the authorities favorably as a substitute for the blackout, which at that time and up to the present is contemplated as a temporary measure to be executed upon receipt of an alarm on the occasion of an imminent hostile air raid. The term "dim-out" temporarily fell into disuse.

Later a special situation arose due to losses of shipping in coastal waters whereof it appeared that land lights visible from the sea contributed in a definite manner, especially by silhouetting effects, to the hostile operations. In particular it appears that the sky glow over towns, even that from very large towns some distance inland from the coast, tended to disclose the location of ships several miles off shore by the operation of the silhouette effect, although no actual illuminants were visible. The steps taken to control the upward flux of light which illuminated the clouds and mist over cities led to a new and more definite connotation for the term "dim-out" which may now reasonably be taken to mean the degree of obscuration necessary to reduce sky-glow or "lume" without any further disturbance of normal lighting practices, except that, in the coastal communities where dim-out has been practised, it has almost invariably been associated with the necessity for extinguishing or shielding lights directly visible from the sea. Lighting situated immediately adjacent to coastal waters and visible from the sea constitutes a special case, of course, and may be treated in various ways according to the necessities of the case, from complete extinction to the mere shielding of seaward direct light for otherwise normal illumination.

Although the observation of sky-glow, and the consequent dimout practices, originated with the special problem of coastal shipping, the subject has aroused considerable interest and several technical studies have been undertaken, some of which have been reported in the press. These studies have contributed information upon the sky-brightnesses involved, upon the relative contributions of the several light sources contributing to the effect, and, to some extent, upon other aspects of sky-glow such as its visibility at great distances and possible effect as a directional beacon. Naturally measurements of this kind are much influenced by atmospheric conditions and by the technical difficulties involved in the measurement of very small quantities, so that the results at present may best be regarded as qualitative indicators. It should also be taken into account that very recently, within the last few days indeed, the military authorities have expressed considerable dissatisfaction with the dim-out as now practised.

The dim-out as practised under military requirements in the eastern and western coastal areas affects street and highway lighting; sign, flood, display and other external lighting; the illumination of shop windows; residential lighting; and automotive lighting. Unlike the blackout exercises that have occurred in many communities, these dim-out measures are permanent, although they still permit a conversion, upon receipt of an alarm, from the dim-out to the blackout condition. It appears, however, that the step from normal unrestricted lighting to the dim-out condition cannot be accomplished momentarily, at least with respect to some of the light contributing elements and according to existing requirements.

From the point of view of effective dim-out alone, the simplest problem is that of sign and other external lighting. In either situation, whether blackout or dim-out, this kind of illumination must be extinguished; in fact, since the purpose of practically all of such lighting is display, no purpose is served by shielding or obscuring it, even if this was a practical possibility.

From different considerations, shop window lighting demands somewhat different treatment. The requirement is, of course, the elimination of all upward directed light that may contribute to sky glow and in the case of shop windows this may include both the direct emission of light from illuminated windows and the upward or random reflection from brilliantly illuminated road surfaces. Several different approaches to this problem have been made apparently with reasonable success. Some of the military orders contain specifications limiting the amount of energy expended in shop window illumination to definite amounts per unit of window area, generally considerably lower than the most desirable practice from a display point of view, although perhaps not unreasonably below average current practice.

In other places much has been done by shielding. The most obvious kind of shielding, namely, by lowered external awnings, appears to be effective so far as direct upward emission is concerned but not as to roadway illumination. Other measures, such as the use of vertical screens, or the blacking off of large portions of the window area, appear to have been satisfactory, either by themselves or in combination with other measures. An ingenious application of optical principles that appears to be successful when the technical features are carefully worked out, consists of the application of gauze-like curtain material, such as certain grades of Celanese, to the inside of windows, whereby much of the outward emission of light is cut off but the display, if the level of illumination upon it is correct, is satisfactorily visible from the road surface. So far as the requirements of dim-out are concerned, these methods appear to be satisfactory, or at least capable of satisfactory performance when properly worked out, but shop window lighting still requires some form of absolute control against the exigencies of blackout alarm, or against the accidental failure of the screening methods employed.

The dim-out requirement for residential lighting is typically that there shall be no unshielded external lighting, such as porch lights or roadway lanterns and that there shall be no visible unshaded interior lighting. The latter requirement appears to be satisfactorily fulfilled so far by the conscientious use of curtains and shades, but since many of these are not opaque they would not meet current requirements for blackout. Further, residential lighting, like shop window lighting, is subject to the general

blackout requirements that all lights shall be extinguished in the absence of persons responsible for their extinction.

Among all of the five categories of lighting that may contribute to sky glow, two of them, street lighting and automotive lighting require the most elaborate advance preparation although their normal effectiveness in use may be in average cases, less impaired than any others. Generally speaking, the requirement for street lighting is that there shall be no upward directed light. In cases of elaborate boulevard lighting it may occur that roadway surfaces, or the vertical surfaces of light colored buildings, will be deemed to be brightly illuminated, and a reduction of lamp sizes or of total lumens from luminaires will be required, but according to the experience of the dimmed-out communities, the requirements are generally met by the use of deep visors or hoods, or by the painting with opaque paint of ornamental glassware, or by the elimination of a certain proportion of the lamps or by one or more lamps in multiple luminaires, or by smaller lamps, and by the judicious use of vertical screens where light colored building walls are present.

Naturally all of this takes time and labor, and a certain amount of materials, preferably not critical materials, and a substantial amount of inspection and detailed adjustment. Once this is done, however, the operation and maintenance of the system may proceed almost in the usual manner, the only further necessity being the requirement for complete extinction in the event of a blackout alarm, which ordinarily would be executed in the same manner as with the system in its normal condition.

Automotive headlighting has appeared in some of the reports as a substantial contributor to sky-glow, although some of the observations have been made under conditions of much greater automobile traffic than is likely to prevail in the near future. The measures taken in dim-out areas have varied somewhat. In some communities automobiles have been required to proceed with parking lights only and this appears to be successful for the purposes of the dim-out but is a severe requirement where an adequate minimum of highway lighting is not provided. A more common, and apparently satisfactory requirement consists of a combination of a required habitual use of the low beam and the masking of the upper half of the headlights. This is less rigorous than the standard blackout requirements, but with controlled speeds permits fairly free movement of unrestricted traffic.

Many other special situations will occur to nearly every reader, and for many of these official consideration has been given and a more or less satisfactory solution has been found. It has not seemed necessary to include them here, because in most cases the solution will probably be fairly obvious if they are approached from the point of view of maintaining conformity with the restrictions placed upon those categories that contribute mainly to the problem of sky-glow and the necessity for dim-out.

EDITOR'S NOTE: A compilation of current dim-out requirements, proposals and ordinances as of Oct. 15, including ordinances and regulations from both the Pacific and Atlantic Coasts, has been prepared by the Institute and is available upon request.

Conservation of Equipment

(*Continued from page* 362)

tion which is necessary to the war effort or to the essential domestic economy, (2) to obtain maximum utilization of equipment, and (3) with the utmost of conservation and provident utilization of rubber and other critical materials. In addition, the Order requires an inspection of all vehicle tires every 5000 miles or 60 days, whichever comes first. This inspection is to be conducted by agencies designated by the Office of Price Administration and a fee will be charged whenever it is necessary to remove a tire from wheel or rim for examination. It is possible that fleet operators who already have sound maintenance programs will be permitted to conduct inspection of their own tires, but this is not certain at present. The Order also states that in all original and subsequent certifications the ODT will be guided by the provisions of its outstanding orders or public statements of policy relating to the operations under consideration.

There are a whole series of records that must be kept and made available for inspection by the ODT field examiners. These include daily, weekly, and quarterly reports that will be used by the ODT as a basis for tailoring vehicle use.

The language of General Order No. 21, and conferences with H. R. Stickel, executive assistant to Commissioner John L. Rogers, plainly indicate that this order is going to be used to enforce the limitation orders, directives, and regulations affecting rubber borne transportation regardless of the agency issuing the order and that the best way for a fleet operator to keep out of trouble and keep vehicles in service is to operate according to the rules and maintain proper records that will stand up under checks made by ODT examiners. Failure to maintain and operate vehicles as outlined in orders of the Maintenance Section of ODT, operating above 35 miles per hour, nonessential use, abuse or overloading of tires, incomplete records or any other infraction of orders will result in an investigation by field men of WPB, ODT, and OPA and cancellation of the operating certificate of the vehicle involved. So far the public utilities have maintained a reputation for willingness to cooperate in connection with the vehicle and tire conservation program and have given the various agencies in Washington far less trouble than any other industry. As a result of this cooperation any changes or modifications in orders or regulations suggested by utility fleet operators have received serious consideration and in most instances the relief requested has been granted through an amendment to the order in question. It is appropriate to quote from Director Eastman's statement explaining the reasons for and the objectives of Order No. 21, that part having particular reference to these certificates:

"I realize that the certificates will be an annoyance and that the first reaction of many will be to regard them as a nuisance. In normal times they could have no justification. But these are not normal times. We are at war, and no war can be fought and won without suffering and trouble. Few things are more essential to an all-out war effort than to keep our commercial motor vehicles, public and private, in active service. The danger that we may lose their services to a considerable extent as time goes on is so great that it demands all possible precautions for the care and conservation of this necessary means of transportation.

"There must be no slackening whatsoever in the efforts which are now being made to save the trucks, buses, and other commercial motor vehicles and their tires. The certificates are intended, not to discourage, but to encourage, stimulate, protect, and augment those efforts. They are only one further means of helping the operators individually to do their full part in the campaign to keep these vehicles rolling in the cause of Victory."

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Residence Blackout Methods and Materials

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A paper presented at the Wartime Lighting Conference of the Illuminating Engineering Society, St. Louis, Mo., Sept. 21-22, 1942

The extensive range of materials and methods explored and proposed by the authors, including the checked methods of positive obscuration of normal residential lighting, supplies an important contribution to the subject of blackouts. The Committee on Defense recommends its careful reading.—Kirk M. Reid, Vice Chairman, Committee on Defense.

THE rules or specifications for blackout of buildings, which include residences, have been set down with concise accuracy and clarity, but the application and material suggestions have often been inadequate for fulfilling the rules. With the advent of wartime blackout requirements—a new experience for this country and a new problem for its engineers—the first research and experimentation had to be devoted to War Department needs, and to the vital problems of maintaining production and transportation under blackout conditions. Obviously blackout of residences is a vital part of the complete effectiveness of a blackout and does involve the larger civilian group.

As the War Department regulations for blackout become better known and more strictly enforced and as more persons endeavor to comply with them, it may be found and experience does already indicate, that many of these first suggestions fail unless the interior lighting is reduced or entirely extinguished.

To consider the blackout problem solved only by substituting dim interiors for good lighting would result in an unnecessary sacrifice. During infrequent trial blackouts of short duration, it is easier to turn out the lights and remain in one place. Furthermore, the unseasoned air-raid warden is likely to feel that the situation is more under control if everything is turned out. On the other hand, if the military is ordering regular and sustained blackout periods for strategic purposes, the time lost sitting in the dark or dim light could assume serious proportions. In the case of actual aerial bombardment, this interference would not be a factor; a properly selected shelter or refuge room would be used. To date it should perhaps be noted the morale of our nation has not had to stand the test of aerial bombardment and blackout with their attendant consequences. If and when it should, the reassuring power of Light, rather than Darkness, to check terror and accident will undoubtedly be revealed and recognized.

The purpose of this paper is, then, to uncover the fundamental requirements of blackout methods and materials which will at once fulfill the Government Specifications[1] and allow the continued use of the better standards of lighting now enjoyed in the United States by more people than in any other country in the world. The latter condition may be one reason why we may not follow British practice too closely, in all respects. Maintaining the current reasonable standards for residence lighting need not increase demands on vital materials or on electrical energy. In fact, the greater concentration of living within a home to reduce the numbers of windows, requiring blackout treatment, and the exercise of simple conservation procedures long recommended, should effect the opposite trend.

The specific materials examined and methods developed in the experiments concomitant with this paper were judged in accordance with their ability to meet the following aims:

1. No light should be visible from the exterior at any angle of viewing;
2. Typical residence illumination values can be maintained on the interior of the window;
3. All blackout materials should have on the room side, reasonably high light-reflection ability, both for high efficiency in light utilization and for heartening aesthetic and psychological effect;
4. Methods should disturb normal drapery treatments and deface window casements as little as possible. Decorative effects must, however, be secondary to the basic requirement of light obscuration; and
5. Availability of materials, practicality of installation and reasonable costs should be constantly weighed in any developments.

The scope of blackout for residences is herein interpreted to extend beyond the refuge or shelter room, occupied only in "active" warfare, to include all such rooms in the home as must be in active evening use if normal living is to go on uninterrupted during the more extended type of blackout. Although regulations for preventing the escape of light remain the same in these two types of blacked-out interiors, their individual treatments vary greatly in aesthetic considerations, durability, permanency of installation, protection against poisonous gases, and mechancial strength to withstand blast and flying glass and debris. No data are included on the resistance of blackout materials to the latter two, as they belong to other fields of research and have been ably handled elsewhere.[2] Likewise no attempt has been made to solve the detail blackout treatment of all the varied types and sizes of window frames, but rather to set down the basic considerations.

Method of Test Procedure

The test "box" used in these experiments is shown in Fig. 1. It was set up in a completely light-tight room. In the large hinged door was hung a standard small-sized double sash, wooden-frame window. The door swung into an enclosed compartment, wired with four sockets in a vertical trough on each side of the opening (150 watts per socket, total 1200 watts). Only light reflected from the white painted rear wall fell on the inside of the window, and in measured amounts from 1 to 300 footcandles since the lamps were placed on a rheostat control.

This arrangement allowed both the application of endless treatments (common drapery as well as blackout) to the inside of the window, and the viewing of the outside of the window under conditions of dark adaptation.

Starlight illumination (.0002 footcandle, measured on a horizontal plane 36 in above the floor) was created in the room by concealing a low-wattage

[1] War Department Specifications, "Blackout of Buildings," 42/1283, April 30, 1942.

[2] "Handbook of Civilian Protection," McGraw-Hill Book Co., Inc., prepared by Civilian Defense Council of the College of the City of New York, edited by Lewis Snyder.
"Protection Against Gas," U. S. Office of Civilian Defense, 1941.

lamp behind the point of observation. The Taylor Low-Brightness Meters, Models A and B,[3] were used in making all brightness measurements.

Typical Illumination Values on Residence Windows

The efficacy of all obscuring materials, except those that are opaque and completely light-locked to the window, is dependent, of course, upon the amount of light striking them. This varies widely between 1 and 300 footcandles, depending upon the number, type and placement of fixtures and portable lamps. Fig. 2 shows typical conditions in average homes in which present-day conservative lighting standards have been incorporated. The illumination value on the window may even approach 500 footcandles in those homes using the 500-watt type floor lamp adjacent to it. The most common furniture arrangements bring lamps close to windows, and in the smaller-scale rooms with several windows, it is almost impossible to avoid direct light from lamps striking the window. Since it is true that light-leak problems become far less troublesome in the 25-footcandle range than with higher values, it may be feasible under some circumstances to move lamps so that no higher illumination values strike the window. If so, Table I may prove of value.

Blackout Materials

A very great variety of materials has been suggested since the outbreak of the war, both authoritatively and loosely, for blackout use, and many have been specially manufactured and promoted in the open market. Experience with many of these materials makes it doubtful that they were viewed under dark-adapted conditions or subjected to amounts of light greater than a few footcandles before they were recommended. It is common for a material to appear opaque for the first 5 to 10 min of viewing, after which time it becomes luminous to readily-measurable amounts. Similarly, it may remain approximately opaque when a low order of footcandles is applied to it, but take on unallowable brightness when the illumination is increased to the 50 or more footcandles occurring in practice on residence windows.

It should be noted that the word "opaque" has been used very broadly in blackout publications in its looser meaning and such references as "semi-opaque," "degree of opacity" are not uncommon.

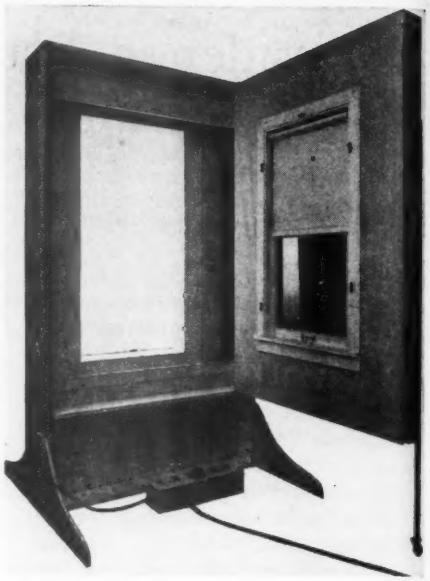


Fig. 1—The experimental test window. Placed in a light-tight room, it affords wide scope for applying and testing an extensive variety of blackout treatments under conditions related to practice.

In this paper, it is interpreted in its strictest sense to mean the ability to withhold *all* light.

In the course of this investigation, a wide variety of the suggested materials, representing a kind of cross-section rather than by any means all of those available, were tested both on the test window previously described and in the laboratory. These are listed in Table II, together with the transmission-factor obtained and the approximate maximum footcandles which the materials can obscure to .00015 footlambert. This value, starlight illumination on a 75 per cent reflecting surface, was arbitrarily selected since some limiting brightness had to be used to establish, in terms of practice, the order of illumination which a specific material is capable of withholding when judged by this arbitrary standard. A window which has a brightness of this order would not be readily visible to the air-raid warden on a starlight night if its frame were white, nor would this brightness be visible from the air. Much higher brightnesses are and can safely be allowed in the Street Lighting Specifications for Blackout[4] because they are not visible from the air and because street lighting conditions may be fixed and readily measured. In residences there are not standard conditions and no method of easy measurement and control. Therefore, the Specifications for Build-

[3] "Brightness and Brightness Meters," A. H. Taylor, ILLUMINATING ENGINEERING, XXXVII, p. 22.
[4] War Department Specifications, "Street Lighting During Blackouts," April 21, 1942.

TABLE I—PLACEMENT OF PORTABLE LAMPS WITH RELATION TO WINDOWS
To Avoid Illumination Values in Excess of 25 Footcandles

Type of Lamp	Bowl Type	Wattage	Distance in Inches*		
			Distance out from Window	Oblique to Corner of Window—45°	In Line With Window to Left or Right from Casement Edge—12″ Out from Wall†
	inches		*inches*	*inches*	*inches*
I. E. S. Table, Floor, or Bridge	8	100	28	25	20
Same Types—Untagged	8	150	44	37	25
I. E. S. Table, Floor, or Bridge	9⅜	50—100—150	40	39	30
I. E. S. Bridge‡	9⅜	50—100—150	31	25	23
I. E. S. End Table	6	100	23	22	18
I. E. S. Senior Floor with or without Candles	10	100—200—300	60	55	39
58″ Floor Lamp	9⅜	100—200—300	52	46	38
58″ Floor Lamp with Baffle	9⅜	100—200—300	46	43	34
Torchiere	16	100—200—300	60	60	45
Senior Floor	12	200—300—500	72	68	53
Table Lamp	No	100	29	27	23
Table or Floor Lamp	No	2—100	50	42	30
Table or Floor Lamp	No	2—60	36	29	23
Bridge§	No	1—100	34	34	28

* Tests were made in a well light-conditioned room in which 8 footcandles, maximum, fell on the window with no lamps within 6 ft in any direction of it.
† These distances would have to be considerably increased if side-leaks were not well controlled.
‡ Shade raised 1½″ above bowl.
§ Downturned shade tipped 45° angle parallel to window.

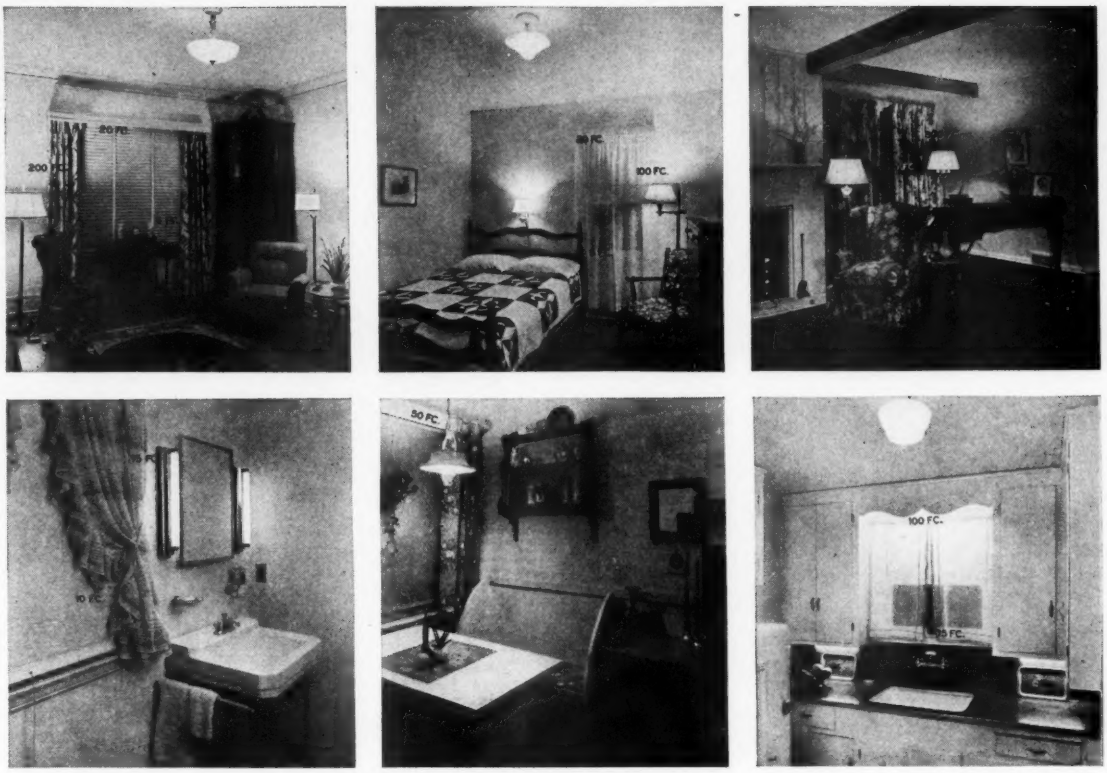


Fig. 2—Obviously the windows in these typical well-lighted rooms are not shown prepared for blackout. The pictures are included merely to illustrate the range of footcandles found on windows when average types of widely distributed and recommended lighting equipment are used with recommended wattage and are placed normally. With lower or higher wattages, the illumination values would be adjusted accordingly.

ings[5] call for *no* visible light, and thus the materials tested could not, in practice, be subjected to the full illumination values given in Column 3 of Table II.

The illumination values given in Table II were not gained by computation, but by actual measurement. Known amounts of illumination falling on one side of the material were varied until the brightness of the other side measured .00015 footlambert. In some cases, this value was at variance with the computed value (limiting brightness—.00015 footlambert divided by transmission-factor), due, it appeared, since this variation occurred most frequently in the case of window shades and fabrics, to the particular texture of the material or character of the filler used. This indicated a varying transmission performance with conditions of varying amounts of light applied to it. Wherever possible, in obtaining the listed transmission-factors, the materials were exposed to 300 footcandles. In the case of the most dense materials, as high as 1000 footcandles were applied. If no brightness through them was then measurable, they are listed as opaque, since they would obscure all the light they would be subjected to in residence practice.

Some observations regarding the characteristics of materials which lead to low transmission or opaqueness may be of assistance, particularly to the manufacturers. It is not alone and necessarily "blackness," as samples 2, 11, 14, 18, 19, 23, and the light wall boards indicate. Obviously black pigmentation is of impressive assistance. Of great importance, however, are the quality of the paint filler, in the case of shade materials, and the closeness of weave, numbers of threads to the square inch, in the case of the unfilled fabrics (note effects of weave and color in samples 21-27). In sateens of different price values, there is apparently great variation of threads to the square inch, regularity of thread, and presence or absence of filler. Note the effect of weave densities upon transmission in the two quality black sateens, and the glosheen, samples 21, 22 and 27. No filler is used in these samples. In sample 26, however, the coarse weave is readily offset by the special filler used. Some quality fillers may tend to reduce the durability of the material, for constant handling can result in cracks that would allow escaping light. The number of layers and the closeness of contact of the layers also have a bearing on the result. In this regard, note in Table II the data given for sample 33. When the enamel cloth and ivory oilcloth were in contact, the test indicated they could withhold over 1000 footcandles; however, it is impossible to maintain this close contact of layers over an entire window, and it was found upon examination in the test window, this combination became visible from the outside (.00003 footlambert) when the light striking it on the inside reached 100 footcandles.

Viewed over a light under a microscope, a number of the materials examined, especially Nos. 1, 2, 3, 21-25, evidenced great irregularity in density over the area of a single sample. This results often in irregular changes in the transmission-factor when more than one layer is used. The sateens, for example, exhibit fine pin points of light between threads, even with two layers. Since these were averaged out with the dark intervening threads in the brightness

[5] War Department Specifications, "Blackout of Buildings," April 30, 1942, Section 2b.

Table II—Characteristics of Materials Considered for Blackout Use*

Materials safe for all home lighting conditions marked †

Description of Materials	Transmission Factor Per Cent‡ (Diffuse Light Source)	Approx. Interior Illumination (ft-c) to Produce Exterior Brightness of .00015 footlambert§
A. *Papers*		
1 Newspapers—4 layers, center unprinted fold staggered	0.021	Less than 1
(a) Light streak—caused in 6 layers when center folds overlap	0.0096	5
(b) Six layers with center folds staggered	0.0006	25
(c) Six layers with one outer side painted black	Opaque	Limitless†
2. Kraft Brown Wrapping Paper, 24″ wide— 40 lb/1224 ft, 1 thickness, uneven density—lightest area	7.5	Less than 1
(a) 4 thicknesses	0.003	10
(b) 5 thicknesses	0.0002	160
(c) 1 thickness—painted black—both sides	Less than 0.00001	Over 1000†
3. Blackout Crepe Paper — Flame Proof—Dennison		
1 layer	0.005	3
2 layers	Less than 0.00001	Over 1000†
4. Creped Kraft Fibre—Midnight Blue —Non-Inflammable, Clopay Corporation	0.00006	200
5. Blackout Safety Screen (sisal craft paper) cord pull	0.00006	200
6. Blackout Shade Company of America (type of sisal craft paper)	Less than 0.00001	Over 1000†
7. Weatherproof Fibre—Black, Clopay Corp.	Opaque	Limitless†
8. 14-Ply Bainbridge Show Card Board 28″ x 44″ sheets. Ivory one side, gray backed	Opaque	Limitless†
9. Saf-T-Black Synthetic Film (applied to glass) General Tire & Rubber Company	Opaque Minor scattered pin points	Limitless†
10. British Standard (BS/ARP14) Window Blind Material—paper	Opaque	Limitless†
11. Corrugated Cardboard	Opaque	Limitless† (if no leaks in side edges)
12. Black Roofing Paper	Opaque	Limitless†
B. *Window Shade Materials*		
13. Oiled Painted—White with dark green back Vellmo Light-Proof Color 51/11	0.026	Less than 1
14. Vellmo Light-Proof #11 (white both sides) Columbia Mills	0.0003	90
15. Oil Painted Duplex No-Lite (white backed with cream) Manufactured by Interstate Shade Cloth Co., Western Shade Cloth, Columbia Mills, The Hartshorn Company and the Illinois Shade Corporation	0.0002	135
16. Pyroxylin — color black Dupont Tontine	0.0002	80
17. Star (hand painted) color black	0.00008	180
18. Vellmo #48—Light Proof, color dark tan	0.00002	750
19. Vellmo Light-Proof Color 5 (dark green both sides)	Opaque	Limitless†
C. *Fabrics*		
20. Green oil cloth, 50″ wide—55¢ a yd.	0.037	Less than 1
21. Black sateen (36″ wide—45¢ a yd.) 1 thickness (63 x 105 threads per sq. in.)	0.24	Less than 1
Two thicknesses	0.0009	15
22. Black sateen (50″ wide—75¢ a yd.) 1 thickness (92 x 133 threads per sq. in.)	0.032	Less than 1
Two thicknesses	Less than 0.00001	Over 1000†
23. Dark brown sateen (36″ wide—45¢ a yd.) 1 thickness (67 x 102 threads per sq. in.)	0.024	Less than 1
Two thicknesses	Less than 0.00001	Over 1000†
24. Dark green sateen (36″ wide—45¢ a yd.) 1 thickness (89 x 124 threads per sq. in.)	0.04	Less than 1
Two thicknesses	0.0004	30
25. Maroon sateen (36″ wide—59¢ a yd) 1 thickness (67 x 105 threads per sq. in.)	0.4	Less than 1
Two thicknesses	0.0043	10
26. Specially treated blackout fabric, M. F. Moran 36″ wide $1.75 per yd., 43 x 110 threads per sq. in., with special filler treatment	0.00007	350
27. Black Gloshen Fabric (36″ wide—89¢ a yd.) F. Schumacher Co. (96 x 160 threads per sq. in.)	0.0006	25
28. Dark gray steamer rug	0.0035	5
29. Heavy weight all-wool blanket, dark gray—near black	0.058	Less than 1
30. Dark blue velour	0.0019	10
31. Crash figured drapery—1 lining coarse tan material, 1 lining black sateen (#22)	0.003	5
Same with 2 linings of black sateen	Less than 0.00001	Near 1000†
32. Fine quality dark brown figured linen drapery lined with fine tan sateen and 1 lining (#22) black sateen	0.0009	15
2 linings (#22) black sateen	0.00002	Near 1000†
33. Black enamel cloth, 50″ wide, 75¢ a yd. (Dupont)	0.0002	85
Same backed with ivory-figured oilcloth	Less than 0.00001	Over 1000†
34. Medium grade Axminster rug—figured pattern 6 picks to inch	0.0013	10
35. Black felt	0.00002 (series of fine pin holes)	700
36. Ivory backed dull black oilcloth (50″ wide, 75¢ a yd.)	Opaque	Limitless†
D. *Synthetic Wall Boards*		
37. Three-ply wood, ¼″	0.00008	180
Painted black outside and edges	Opaque	Limitless†
38. Masonite, 3/32 and 1/8″	Opaque	Limitless†
39. Press Board—soft, ¼″	Opaque	Limitless†
40. Tekwood, 1/16″	Opaque	Limitless†
41. Blackout panel, asphalt treated felt Flintkote	Opaque	Limitless†

* Manufacturers' and trade names only given for purposes of identification.

‡ A six square inch area measured over diffusely lighted opal glass which had a controlled and known brightness, under conditions of dark adaptation with Taylor Low Brightness Meter. Variations in manufacturing process often produce marked variations in product; data included on one sample of material only. The light and dark spaces of porous materials were averaged by interposing a diffusing screen between the material and the meter.

§ See text—Blackout Materials.

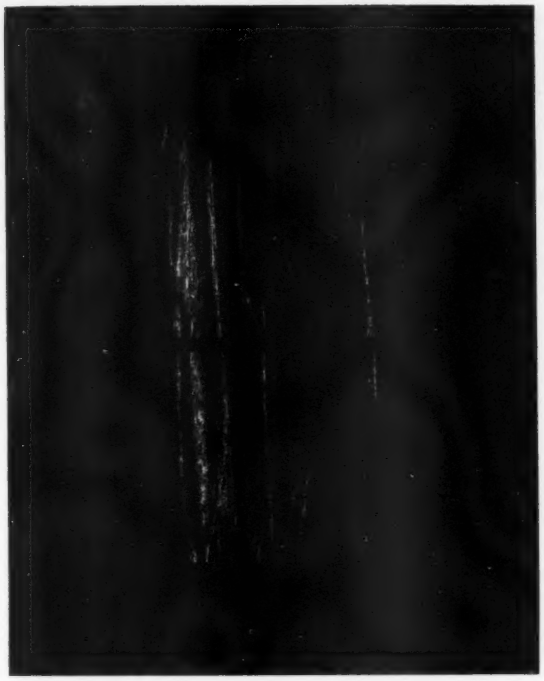


Fig. 3—Unlined pleated dark blue velour draperies glow when less than 10 footcandles strike the inside of the window.

Fig. 4—Effects such as this obtain unless window obscuring material is made light-tight. Note reflections on window fittings.

readings for the Table II data, the results indicate a better rating for their blackout application than does actual practice. On the test window two layers of the black sateen alone, sample 22, became visible with approximately 300 footcandles.

Low brightnesses which do occur may be obliterated either by moving light sources in the interior further away from the window or by pulling down ordinary window shades or closing Venetian blinds before the blackout treatment is applied (providing there is no light-leak, since even minor leaks are intensified by the light surfaces of shades or blinds). It seems unfortunate that so frequently recommendation is made to utilize blankets, velvet draperies or portiers, (Fig. 3) bedspreads, and rugs for blackout purposes. Not only do these in general have relatively high transmission, but they offer extremely awkward problems in application, due to their bulk and to the extreme difficulty in avoiding light-leak around the edges.

Light-Leaks Around Windows and Doors

Windows

Unless proved means of preventing light-leaks are carefully employed, regardless of the efficacy of the material selected, the whole blackout effect may be destroyed (Fig. 4). Means of eliminating leaks from interior room lighting of all normal values, and providing complete freedom for furniture and lamp placement, can be devised. This, however, can only be accomplished by paying meticulous attention to details. A number of ways to prevent light-leaks are included in this study and are grouped according to the physical characteristics of the obscuring material, with consideration also given to the overall treatment of the windows and doors for which they are suggested. Many of the principles and details in these studies applied to other problems can provide assurance of satisfactory results.

1. Removable Medium Weight Rigid Window Insets

Wall board materials placed inside the reveal, and against side and top window stops, should fit closely along all four sides of the opening. Leaks around the entire window can be eliminated by gluing black, gray, or dark-colored ¾-in wide felt or weatherstripping along all four edges, leaving an overlap (Figs. 5 and 6). Do not overlap the felt at the corners but miter, or use butt-joints (Fig. 18), drawing them together to avoid bulges. The obscuring inset must be practically flush with the inner surface of the window trim so that the felt or weatherstripping *lies flat* across the small opening which otherwise would be a light-leak.

When the window stop-strips are removed from the face of the trim farther than the thickness of the sheet material used, a filler strip should be added along the stop-strip to bring the inset sheet flush with the trim. Turn buttons hold inset in place (Fig. 5).

When stop-strip is flush with the trim, this method of blackout cannot be employed. In the latter event, sheets of these materials should be properly painted to withstand weather and provide against warping so they could be used on the outside of the window. These sheets should be cut to fit closely on all four edges of the opening so that they can be brought up inside the casing and against the outer stop-strip to rest on the sill. Felting should be applied along all four edges on the interior side. Small hooks and eyes are placed along sides, top and bottom, to hold inset in place and to draw it against the stop-strip. This type of obscuring screen can be put in position with the upper sash lowered, just as wire screens are put in place from the inside.

2. Removable Light Weight Overlap Obscuring Screens—Fabric Edging as Frame

In this type of treatment, paper and shade-obscuring screens to overlap trim at sides and top, rest on the stool. When these materials are placed against win-

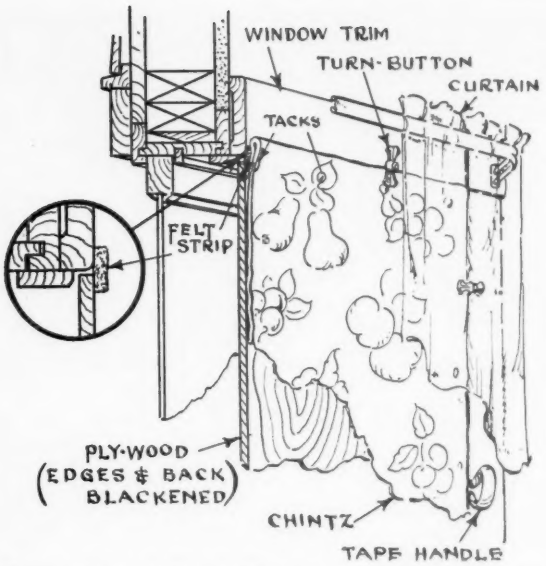


Fig. 5—(above) Sketch illustrates the use of chintz over plywood inset, with details of applying felt edge and turn buttons. See Fig. 6.

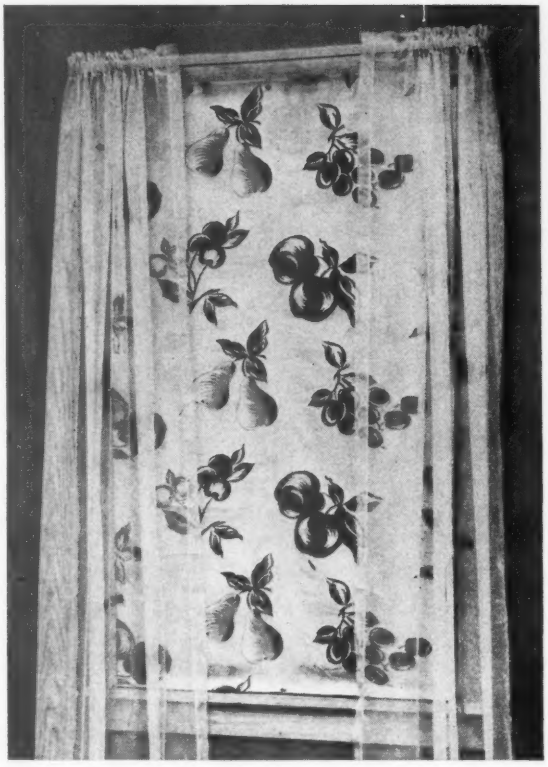
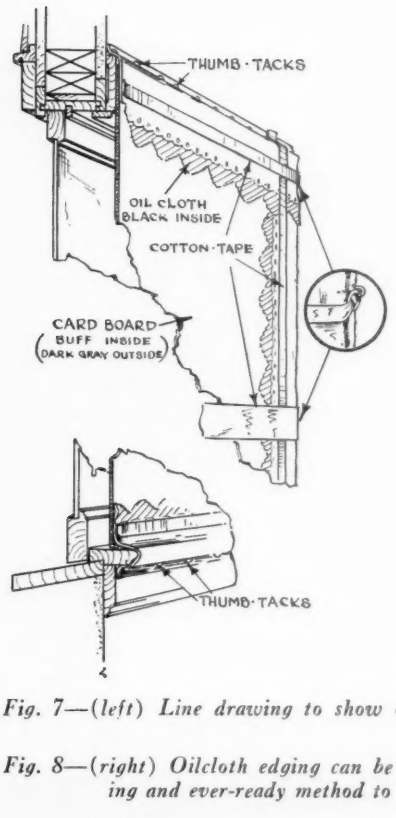


Fig. 6—(right) Simple and attractive treatment of chintz over plywood for breakfast rooms and bedrooms.

Basically applicable to many windows, and also offers a wide variety in decorative window possibilities. See Fig. 5.



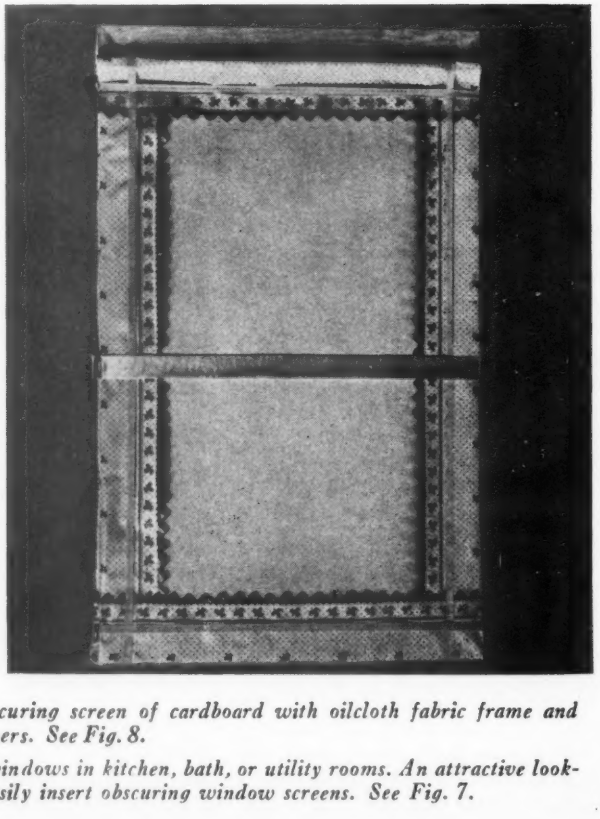
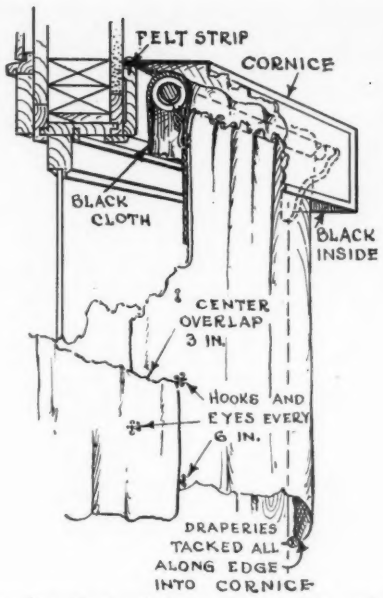


Fig. 7—(left) Line drawing to show overlap of obscuring screen of cardboard with oilcloth fabric frame and tape fasteners. See Fig. 8.

Fig. 8—(right) Oilcloth edging can be retained on windows in kitchen, bath, or utility rooms. An attractive looking and ever-ready method to quickly and easily insert obscuring window screens. See Fig. 7.



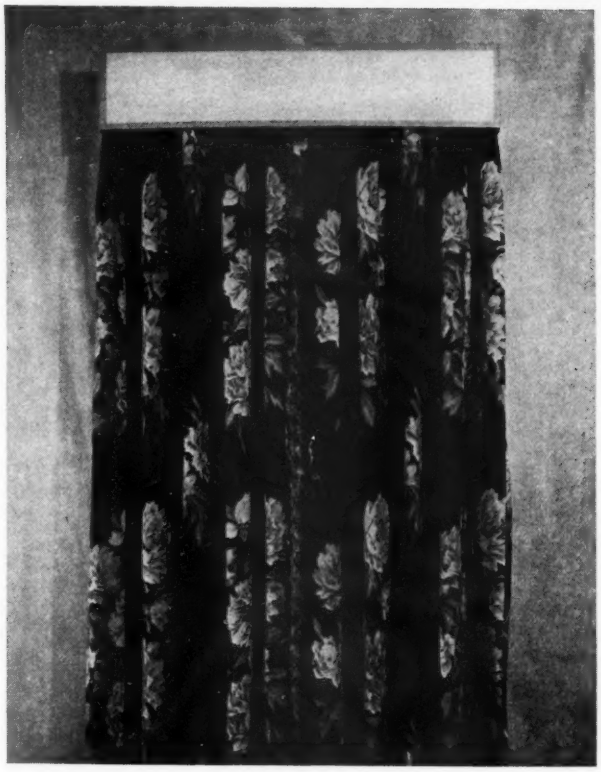


Fig. 9—Detail of window cornice and method for utilizing sateen lined window draperies. See Fig. 10.

Fig. 10—(right) A home-made cardboard window cornice painted black on the inside with double sateen linings and overlapping draperies at the center, provide method to attractively treat a wide variety of living room and dining room windows. See Fig. 9.

dow trim, they produce definite light-leak problems since they do not readily conform to the contour of the window trim as do fabrics or softer, more pliable materials, which tend to cling to it. Therefore, when obscuring screens, as herein mentioned, are used, they must be held against the trim and made secure from leaks. One method which is satisfactory for this purpose is the application of flexible fabric attached to the window casement to form a frame into which the obscuring screen can be set in place and easily removed (Fig. 7). The frame must also be made leak-proof at its place of joining the window casement. Six-inch scalloped oilcloth edging was thumb-tacked securely to the outer return of window casement (Fig. 8).

Another method not illustrated makes use of a narrower gummed-oilcloth shelf trim which can be used when applied to the front edge of the window casement because it readily adheres to the trim and forms a leak-lock.

When blackout shades mounted on rollers are used, or those with pull-cord attachments are placed on upper-casement window trim overlapping the window opening, methods to seal light-leaks at the top and side need careful handling since normal overlapping alone is not sufficient. Side channels or slots should be fastened to the outer return of the window casement as described under No. 2 above, paragraph 1. Space at the top of shade usually increases when shade is drawn down. (See Nos. 5 and 6 for suggested methods to use.) Blackout window shades mounted between window stops are of no value in eliminating leaks.

3. Overlapping of Fabric Materials Beyond Casement—at Sides

Light leakage can be eliminated when full pliable materials are used if they fall in soft folds overlapping the window casement 12 inches on the sides. It is also necessary to fasten them to the baseboard at the bottom or under the stool on the apron and employ some method to stop top-leaks since hanging materials above the window casement does not overcome this difficulty, even when the curtain pole is in close contact with window casement or wall. (See No. 5 for preventing top-leaks.)

4. Fabric Materials Attached to the Casement

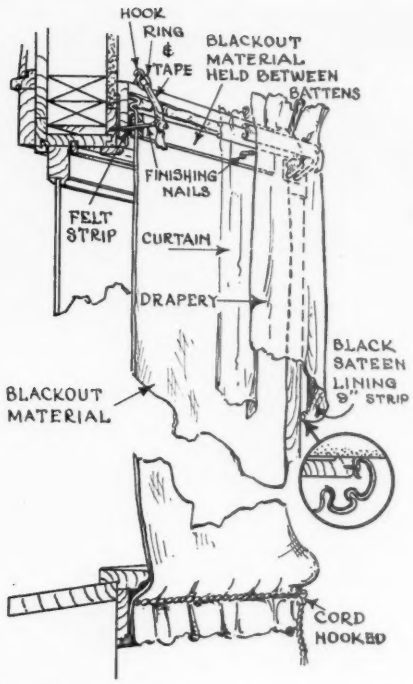
Lined fabric materials may also be made secure against light-leaks at the sides by fastening them to the outer return of the window casement on their reverse side (Fig. 11) to further protect against leakage and to effect a smooth appearance.

5. Fabric Materials in Window Cornice —When Fabrics Can be Drawn Closed

Draperies, lined with two thicknesses of sateen, require a 3-in overlap in the center with side leaks stopped by methods suggested in No. 3 or No. 4 above. A 7-in continuation of the sateen lining at the top of the draperies when placed over the window pole in combination with home-made window cornice (Fig. 10) is satisfactory when the cornice is painted black on the inside and weatherstripped where attached to window casement and wall to further eliminate possibility of leaks. A 3-in overlap is sufficient when two full-length *staggered* rows of large-sized snap fasteners are placed 6 inches apart from top to bottom of the draperies (Figs. 9 and 10).

6. Combination of Fabric Materials (Window and Side Draperies) Employing-Wood Batten

Side draperies with a 9-in double-sateen lining at their outer edges can be combined with window-obscuring material in the following way. Double-sateen, partially-lined side draperies are permanently fastened to return window casement on their reverse side (Fig. 11). Removable fabric obscuring material is



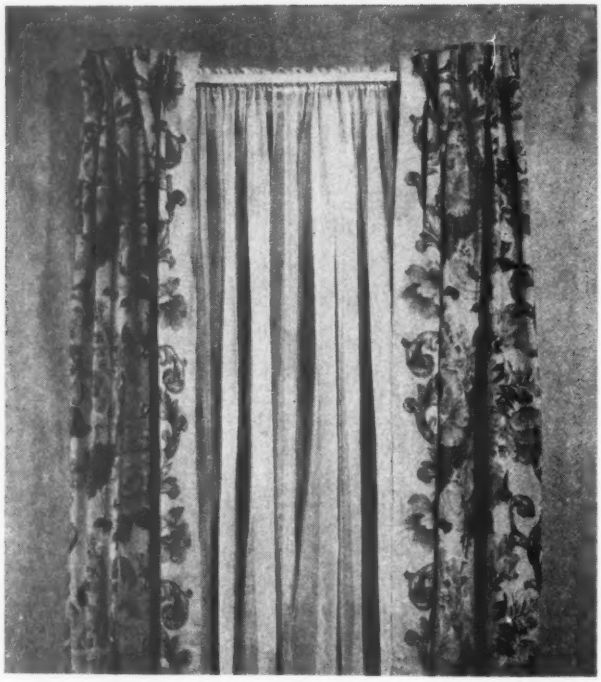


Fig. 11—Sketch of wood batten and detail of its attachment to window frame. Note side light-locks with narrow side lining of sateen on draperies. See Fig. 12 at right.

Fig. 12—This treatment specially applicable to living and dining rooms shows narrow side draperies with glass curtains to partially conceal dreary blackout window material and to help increase light reflections on the room side. See Fig. 11.

attached to a felted or weatherstripped wood batten with a 2-in overlap of the material at the top for filler, extending from edge to edge of the window casement. Mounted on headless finishing nails on the middle upper casement leaving drapery fittings intact, tape fasteners hold batten more securely in place. At the sides no leak is possible because partially-interlined draperies form a leak-lock with window-obscuring material.

No discussion has been given on the treatment of the upper and lower window sashes separately, although many experiments were made in this regard. Doing so in some instances increased the work of installation, although such procedure also offered some advantages with those materials easier to handle and easier to obtain in smaller sizes. For example, newspapers need to be bound together on their four edges, and to eliminate leaks they should be cut approximately 1 inch larger than the pane. Thev must also be sealed with opaque scotch tape or thumb-tacked with additional wide newspaper folds to hold them between sash and stop-strip. Corrugated paper more readily obtainable in small sizes should be cut to fit or to overlap the frame, and should be sealed on edges with removable tape each time it is used. Obscuring materials separately placed in each window frame also offer complications where there is definite need to consider interference of window hardware such as locks, handles, and sash-weight cords as well as the likelihood of having to seal the joint across the upper and lower sash where the two meet in the middle.

No reference has been made to the use of paint on windows, not only because of the problem of its removal but also because this procedure would require the continual use of artificial light—even in the daytime. Black opaque scotch photographic or mending tape was tested as a substitute for paint. It was placed on the inside of the window pane to form a 3-in or 4-in frame to outline both the upper and lower sashes, with precaution taken to overlap the joining by ½-in between the window frame and the glass. This method helped to eliminate minor leaks by affecting a cut-off at normal viewing angles.

Universally-recommended wood frames incorporating blackout material may necessitate the removal of all normal window drapery material and window fittings. When attached to the casement these frames must be felted to eliminate leaks, or attached to the outer window casement reveal.

Doors

Provision to eliminate visible light between connecting rooms, halls, and passageways are treated in the following numbered sections to include interior door openings and archways with and without doors, as well as exterior doorways with and without window panes. Only those exterior and interior doors and doorways which are to obscure interior lighting from adjacent spaces need be considered.

7. Doorways on Which Doors are Mounted

Dense, full fabric material or curtains placed over openings with doors are suggested to provide for additional protection. If the material is securely fastened over the top and down one side of the door frame on the opposite side from the door swing, it allows additional protection for the respective opening and/or closing of the door and/or curtain, when entering or leaving the room.

8. Framed Doorways or Archways Without Doors

This method requires the use of two full-sized draperies or curtains, and each

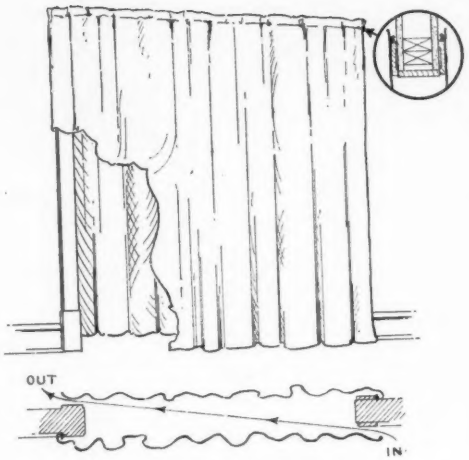


Fig. 13—Line drawing to illustrate one method to light-lock openings between two rooms.

Fig. 14—Officially approved blackout lamp.

side of the door opening or archway is treated separately. On one side of the opening one curtain is attached to the top of the door frame and to the side of it. Rings closely spaced and sewed to the top and sides of the curtain are hung on hooks to accommodate them placed in the return of top casement (Fig. 13). Flat traverse rods afford a more flexible method but are more expensive. Likewise, on the other side of the opening or archway the second curtain is attached and fastened to the top of the door frame in the same way and down the opposite end of the opening from the first curtain. By attaching the curtains at opposite ends, a "tunnel" between the two is effected (Fig. 13). When not in use, the curtains can be easily removed.

9. Swinging Doors

A stop-strip placed on inner reveal of door frame will temporarily prevent the double swing of a through-door. Felt or weatherstripping on stop-strip as well as applied on hinged side of door will prevent leaks. Treat further as suggested in No. 7.

10. Exterior Door Openings With and Without Window Panes

Treat all exterior doors having window panes as suggested under Window Treatments, and also as suggested in No. 11.

Unless exterior doors fit snugly, seal entire joining of door and frame with weatherstripping or felt as suggested under No. 1.

11. Under-Door Leaks (Exterior and Interior)

Rugs or small pieces of carpet will help to eliminate minor leaks when placed closely against under-door cracks, but are not satisfactory unless anchored against the door and held firmly in place. Homemade "sausage" sand bags are suggested for under-door leaks since they are easy to make and satisfactory to fill light cracks.

The Use of the Indoor Blackout Lamp

In the War Department Specifications for the blackout of buildings, one intermediate measure is allowed between the complete obscuration of all interior lighting and turning off of that light, called "Reduced Illumination." This method provides a small amount of controlled illumination, sufficient to permit reasonable facility of movement without necessitating complete blackout of doors and windows. It is permitted, however, only when such indoor lighting units are employed as have been tested to meet Government Specifications for them, and are clearly marked "Indoor Blackout—War Dept. Standard," and carry the code number issued it upon testing. An incandescent lamp (Fig. 14) has been designed and approved for this important purpose, and its use must be in accordance with the following directions[6]:

"(a) In any one room, only one unit is permitted to each 200 sq ft of floor area or a fraction thereof.

(b) Units shall be spaced not less than 10 ft apart in any direction.

(c) In corridors, one row of units is permitted at a spacing of not less than 15 ft.

(d) Units shall be placed at least 3 ft from any window, exterior door or other opening.

(e) Units shall not be pointed toward any window, exterior door or other opening.

(f) When openings are covered in the usual manner with drawn window shades, drapes, blinds, or even with one thickness of newspaper or whenever each unit has a shade which screens the unit from outside observation above the horizontal, units may be installed at any height.

(g) When exterior openings are not covered, and when units are not otherwise shaded from outside observation above the horizontal, blackout units shall be located above the top of such openings."

These lamps are not available now for ordinary residence use, but it is expected that they will be made available to those areas dictated by the War Department when conditions warrant their manufacture.

Since only two minutes are allowed after the alert signal to effect blackout, it is obvious how valuable these lamps will be in enabling the householder to apply blackout treatments when several windows are involved. Their use in halls, passageways, and rooms not to be actually lived in, but which must be traversed, will greatly reduce the numbers of rooms and windows which need specific treatment.

The listed general requirements[6] of indoor blackout lighting units are:

"Initial lumens—minimum 1½, maximum 3 (light-adapted eye).

Initial candlepower at any angle—maximum 1 (light-adapted eye).

[6] War Department Specification 42/1283 Section 2c.

Light distribution—most of light in one hemisphere; in other hemisphere, not more than 0.15 lumen.

Color—orange or orange-red.

Rugged construction and not subject to derangement, tampering, or misuse."

Ventilation

With all lights off, the mere opening of doors and windows can provide natural cooling and changes of air in the most simple manner. By turning on approved blackout lamps or units in an opened house, limited activity can take place at the same time. When, however, the well-lighted room, ventilation, and complete outside blackout are combined, the study of the problem must include baffles, louvers, and even shields. Here again the present studies include the obscuration of well-lighted rooms. When the interior lighting is low or quite moderate, the problem is far less exacting.

All inner surfaces of the ventilation light-trap must be finished with a good dull black. The difference between regular reflections, as obtained from smooth and polished surfaces, and spread reflections from varying degrees of the dullness of surfaces, must be recognized. The paths of a single ray of light as shown in the simple diagram of Fig. 15 serve to illustrate the predominant direction of the flow of light through a ventilator, but they are not adequate to

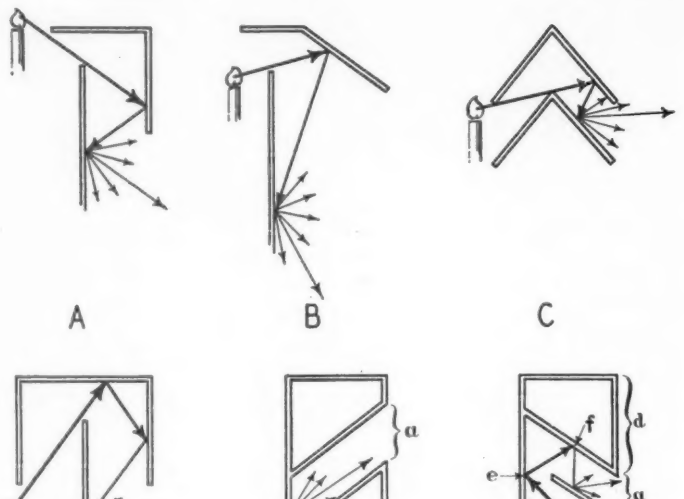
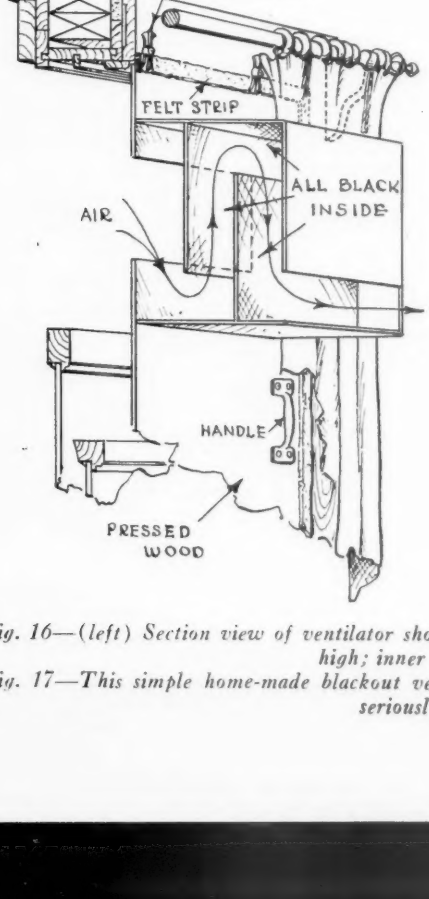


Fig. 15—Illustrating ventilating baffle designs and reflections which control light-leaks. All inner surfaces must be painted dull black.

Inadequate control with A, B, C, and E, since light escapes after the second reflection. Even light escaping from the third reflection as in D is undesirable since it can be viewed at and above the horizontal.

Design F shields the second reflection at (e) and the third at (f) and only fourth-reflection light may be viewed at or above the horizontal in the order of starlight brightness when 300 foot-candles are striking the inner side of window.



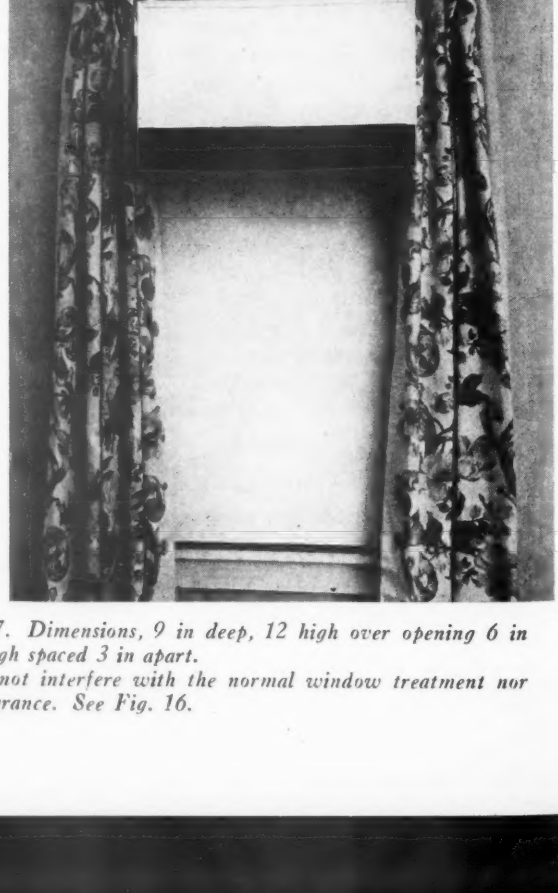


Fig. 16—(left) Section view of ventilator shown in Fig. 17. Dimensions, 9 in deep, 12 high over opening 6 in high; inner baffles 9 in high spaced 3 in apart.

Fig. 17—This simple home-made blackout ventilator does not interfere with the normal window treatment nor seriously impair appearance. See Fig. 16.

cover the entire situation. Studies of ventilation light-trap designs based on these simple "reflection-incidence" diagrams can only be indicative and are often misleading. Such diagrammatic illustration of the principle involved does not make clear the two following very important conditions that have pertinent bearing on the adequacy of the result:

1. There is no ordinary condition indoors that is comparable with the point light-source, for the whole interior is contributing light toward the window from every conceivable angle.

2. There is, naturally, scattering of light in all directions with dull interior surfaces in the light-trap.

For simplification, these contributing conditions are omitted in the drawings except at the point of last reflection.

Good dull blacks appear to be lifeless and at the ordinary brightness encountered, they are. But when we attempt to absorb *all* or *nearly all* light by as few dull black reflecting surfaces as is possible and the result is viewed under blackout conditions, it is noted that there is a scattering of light in all directions.

The diagrams in Fig. 15 serve for an indicative study since they represent some of the fundamental arrangements that come to mind. This group of sketches does not illustrate all of the possible relative or angular placing of parts. In diagrams A, B, and C, the second reflection scatters light outward in all directions. In addition, the scattered light reflected from the first surface (A and B) would illuminate the frame and the sill of the window below it. If the illumination striking the first surface were 10 footcandles, and the reflection of the black surface 3 per cent, the brightness of the second reflection might be 0.009 footlambert or 60 times starlight on a light-colored house (0.00015 footlambert). By computation, the brightness following the third reflection could be 0.00027 footlambert, a value still above the 0.00015 footlambert. To provide a good margin of safety, a fourth reflecting surface appears to be needed. In fact, when designed to hold in values up to 100 footcandles, the fourth surface is required. The computed brightnesses after the third and fourth reflection, starting with 100 footcandles, are 0.0027 and 0.00008 footlambert, respectively. By experiment, the need for four-surface reflections, better considered as absorptions, was borne out and even the shielding such as (d) in sketch F is important. Sketch E reversed, produced F. In this instance surface (d) comes down over the opening to shield the inner surfaces along (e) and (f) that can now only be viewed below the horizontal. Arrangement F also illustrates its superiority over E in shedding water in case of rain or snow.

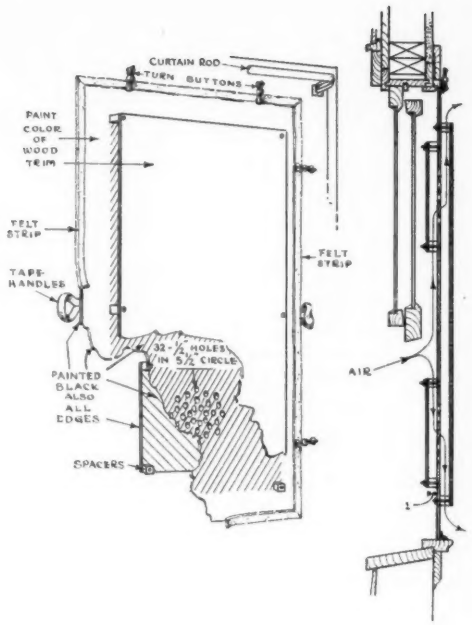


Fig. 18—Another practical ventilator device uses the rigid window inset as a base. There is no limit to decoration possibilities for the room-side surface to make it harmonious with the interior treatment.

The ventilator illustrated in Fig. 16 incorporates the foregoing principles, uses available materials, and can be readily made at home. Its size was held to a minimum to reduce bulk, and it was applied to the rigid window inset with scotch photographic tape—black. When completed, the whole unit was painted to match the drapery background. In the photograph (Fig. 17) the felt stripping was left unpainted to emphasize its requirement to avoid light-leak. This model, by actual test, held back an illumination of 300 footcandles over its entire surface. The brightness viewable from the outside, on and below the horizontal, was zero. Above the horizontal at 35 degrees from the vertical, there was a measurable brightness of approximately 0.0002 footlambert.

A second ventilator (Fig. 18) using a rigid window inset as a basis also proved satisfactory since it completely obscured 300 footcandles. During tests on it, the plywood was removed between the holes to form a square opening. This, however, reduced the baffling to such an extent that material brightness could be noted on all sides of the window casing.

Fewer absorbing surfaces can be used for trapping light by nearly closing the internal baffles, but with reduction of air flow. In sketch D, the center panel could be an opaque window run up to form a very small opening. This would reduce both the escaping light that would travel over and down the front of the window and the air intake.

If such treatments can be applied to two windows that are so situated to allow draft, the results will be far more effective. With only one window so handled, the degree of ventilation will naturally be greatly increased by the use of an electric fan.

Conclusions

1. These investigations establish that it is both possible and practical to obscure completely—in accordance with present government specifications—even the best lighted residence interiors without disturbing normal lighting arrangements, and without seriously affecting decorative appearance.

2. Since this is proved so, there appears to be no reason for the drastic measure of turning off main switches in individual or apartment dwellings which has been misguidedly assumed essential by some air-raid wardens. At the present time this common procedure undoubtedly stems from inexperience with the possibilities, unfamiliarity with the Government Specifications, from the reliance upon the most obvious and easiest procedure for spasmodic blackout drills, and, obviously, from lack of planning.

3. It is self-evident that the householder would be wise to adjust living habits sufficiently to avoid the necessity

(*Continued on page* 384)

Discussion of the Interim Report on Guides for Overloading Transformers and Voltage Regulations

By M. S. Oldacre
Chairman AIEE Transformer Subcommittee

Presented at Joint Meeting Electrical Equipment Committee and Transmission and Distribution Committee, EEI, Cincinnati, October 19

THE present war situation in our country is such that those industries not directly engaged in war production must operate on a minimum supply of critical war materials. Even this minimum has been cut from month to month and is rapidly approaching zero. To the utility industry this means no new equipment except for war industries. The situation must be met by overloading existing equipment beyond peace-time standards and by selecting new designs based, not on economic life, but on maximum output from the minimum amount of critical materials.

It was to meet this situation that members of the Transformer Subcommittee of the AIEE proposed at an informal meeting on May 13 of this year to issue a special report on "Guides for Operation of Transformers." It was hoped that such a report could gather together and summarize the best available information on overloading of transformers and, at the same time, clarify and correct some of the misleading and conflicting ideas that had already been given to the industry. Through the concentrated effort of the working group of the committee, the report was completed and presented at the summer convention of the AIEE, all within six weeks of the first informal discussion, and has since appeared in the September issue of *Electrical Engineering*.

The report represents a compromise of views of engineers from both the manufacturing and the operating fields of the industry. It will permit considerably more loading than was thought proper in the past, but it is considered safe for *immediate general* use. Care has been taken to point out some of the limitations and cautions that should be observed in applying overloads to transformers and regulators, as many of the characteristics that have needed little consideration in past normal operation may become of exceedingly great importance in overloading.

The transformer loading problem can be approached from several points of view:

1. Carrying more load on existing units without change in the cooling facilities of the transformer and (a) still obtain normal life expectancy of the transformer, or (b) with some sacrifice of the life of the transformer.
2. Carrying more load than normal design practices on either existing or new transformers by adding supplemental cooling facilities and (a) still obtain normal life expectancy of the transformer, or (b) with some sacrifice of the life of the transformer.

It seems in most cases that supplemental cooling is the usual solution to obtain more capacity, but by taking into account the conditions actually existing, considerably more load may often be carried without adding anything to the cooling equipment.

The phrase "normal life expectancy" was used in the report to designate the life of the transformer that should be obtained if the unit is operated at rated load and temperature conditions in accordance with the ASA Standards for Transformers C-57 and the accompanying guides for loading transformers.

A little explanation of the basis of rating may be in order, as the information in the standards and in the interim report does not seem to be fully understood. First, the rating of a transformer includes the load that can be carried with a specified temperature rise, usually 55 C for oil-immersed transformers. No reference to the ambient temperature is included in the rating, but in the guides for operation it is stated that the load that can be carried (this is the "load capability" mentioned in the report) is determined by the ambient temperature Furthermore, normal rated load can be carried continuously provided the temperature of the cooling air at no time exceeds 40 C and the average temperature during any 24-hour period does not exceed 30 C. This means that at rated load and average ambient the hottest-spot temperature will be 95 C, assuming 55 C rated rise and 10 C hottest-spot allowance.

Recently, there seems to have been a tendency by some engineers of the manufacturing companies to interpret this rating as being based on a steady ambient of 30 C without permitting any averaging of the daily temperature to obtain the daily average ambient of 30 C. If this flat 30 C ambient were recognized, we would have a further limitation on the output of our transformers.

With the 95 C as a starting point for normal life expectancy, operation at higher temperatures will cause a decrease in the life of the transformer as determined by the tensile strength of the insulation. The controversial question has been and still is: how much decrease in life will occur at increased temperatures. The data published by the late L. C. Nichols in 1934 and that by V. M. Montsinger at various times are referred to very frequently. More recent test data as referred to in the report still were not in entire agreement but the Transformer Subcommittee agreed, as a compromise of the various views, on the time and temperature given in the report as the values which would cause a moderate loss in life of the insulation. "Moderate loss" of life was considered to be not more than 1 per cent of the normal life for each emergency operation for the length of time and corresponding temperature given in Table I. It was believed by most members of the committee that the 1 per cent is a high figure.

The report first considers the increased output for normal life expectancy. This offers more possibilities than usually recognized. Next is considered emergency loading with moderate sacrifice of life.

By proper allowance for low ambient temperature, and for low load factor, along with design characteristics and installation limitations, peaks as high as 145 per cent of nameplate rating can be carried without appreciable sacrifice of normal life expectancy. The various rules covering allowances for ambient and load factor are combined very conveniently in Fig. 1, which appears in the report.

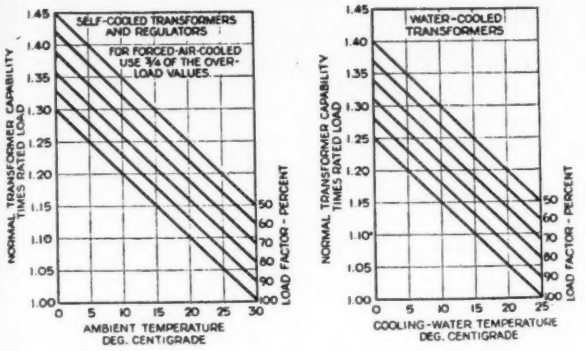

SELF-COOLED TRANSFORMERS AND REGULATORS
FOR FORCED-AIR-COOLED USE ¾ OF THE OVER-LOAD VALUES
NORMAL TRANSFORMER CAPABILITY TIMES RATED LOAD
LOAD FACTOR - PERCENT
AMBIENT TEMPERATURE DEG. CENTIGRADE
WATER-COOLED TRANSFORMERS
COOLING-WATER TEMPERATURE DEG. CENTIGRADE

Fig. 1—Transformer and regulator capabilities for normal life expectancy.

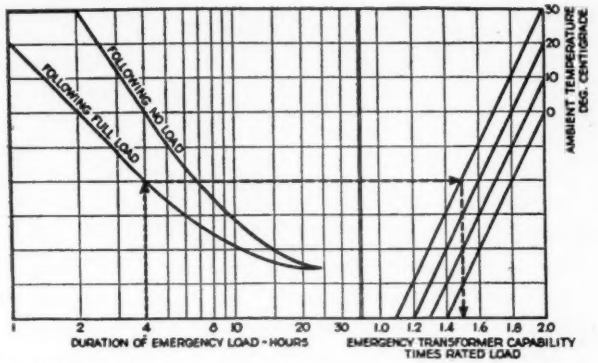

FOLLOWING NO LOAD
FOLLOWING FULL LOAD
DURATION OF EMERGENCY LOAD - HOURS
EMERGENCY TRANSFORMER CAPABILITY TIMES RATED LOAD
AMBIENT TEMPERATURE DEG. CENTIGRADE

Fig. 2—Emergency load capability of self-cooled transformers larger than 500 kva.

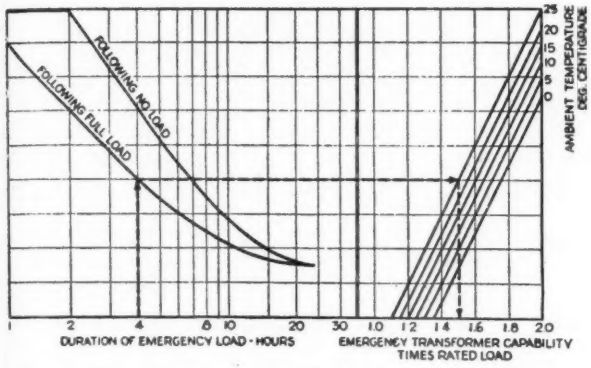

FOLLOWING NO LOAD
FOLLOWING FULL LOAD
DURATION OF EMERGENCY LOAD - HOURS
EMERGENCY TRANSFORMER CAPABILITY TIMES RATED LOAD
AMBIENT TEMPERATURE DEG. CENTIGRADE

Fig. 3—Emergency load capability of water-cooled transformers larger than 500 kva.

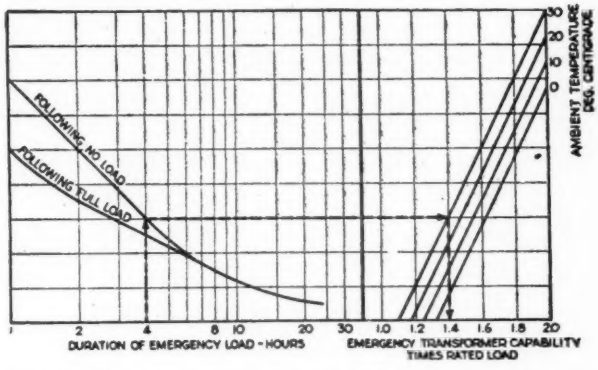

FOLLOWING NO LOAD
FOLLOWING FULL LOAD
DURATION OF EMERGENCY LOAD - HOURS
EMERGENCY TRANSFORMER CAPABILITY TIMES RATED LOAD
AMBIENT TEMPERATURE DEG. CENTIGRADE

Fig. 4—Emergency load capability of forced air-cooled transformers larger than 500 kva.

The normal rating of a transformer may be further increased by the addition of supplemental cooling in the form of fans, water spray, or external oil coolers. Because of the wide differences in individual transformers, increased ratings based on supplemental cooling should be applied only after careful consideration of each case. Although it might be possible in one case to increase the permissible output by as much as 66 2/3 per cent, still in other cases, particularly in older transformers, the net gain might be very small. There are so many variables involved in extensive overloading that it is advisable to check each case with the manufacturer.

The permissible overload in all cases is dependent on the characteristics of the individual transformer, such as the ratio of copper loss to iron loss and the physical limitations of the parts of the transformers such as bushings, leads, and soldered connections.

For emergency loading with moderate sacrifice of life expectancy, the limiting factor is the rate of deterioration of the winding insulation at the hottest-spot temperature of the windings as discussed a little earlier. Table I of the report shows temperatures and load durations which are the basis of emergency loading.

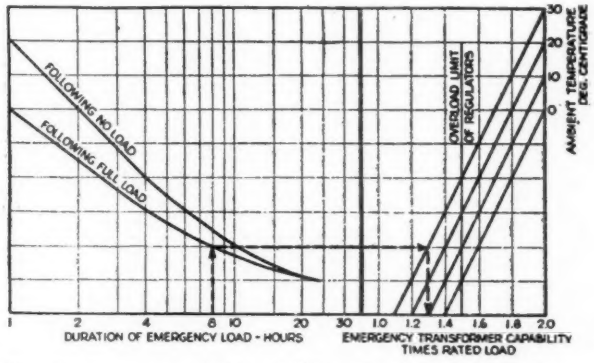

FOLLOWING NO LOAD
FOLLOWING FULL LOAD
OVERLOAD LIMIT OF REGULATORS
DURATION OF EMERGENCY LOAD - HOURS
EMERGENCY TRANSFORMER CAPABILITY TIMES RATED LOAD
AMBIENT TEMPERATURE DEG. CENTIGRADE

Fig. 5—Emergency load capability of self-cooled transformers (500 kva or less) and of regulators.

For comparison, Table I-A shows the same table with comparable hottest-spot temperatures from C-57 Guides for Loading Transformers.

Table II shows the time-temperature information of Table I converted to a form that will apply to the average transformer in a more usable form. Again for comparison with C-57 data, Table II-A shows short-time emergency overloads for transformers rated above 500 kva from both the Interim Report and C-57 Guides for Loading Transformers. This shows the margin of increased loading made available by consideration of emergency loading with moderate sacrifice of life expectancy.

The first table of permissible loading applies to transformers larger than 500 kva, while Table III applies to transformers rated 500 kva and below and to regulators.

The permissible overloading based on low ambients and load factors may be

TABLE 1. TEMPERATURES FOR SHORT-TIME EMERGENCY LOADS WITH MODERATE LOSS OF LIFE OF INSULATION

Duration of Load, Hours	Hottest-Spot Temperature, Degrees Centigrade
1	137
2	130
4	125
8	120
24	110

TABLE 1A. GUIDES FOR OVERLOADING TRANSFORMERS—LIMITING HOTTEST SPOT TEMPERATURE

Comparison of Interim Report with C-57

Duration of Load-Hours	Limiting Hottest-Spot Temperature—Interim Report		C-57
	Emergency	Emergency	Recurrent
1	137	...	...
2	130	115	110
4	125	...	...
8	120	110	105
24	110	105	95

TABLE 2. SHORT-TIME EMERGENCY OVERLOADS FOR TRANSFORMERS RATED ABOVE 500 KVA*

(Times Rated Load)

Duration of Load-Hours	Self-Cooled and Water-Cooled		Forced-Air-Cooled	
	Following Full Load	Following No Load‡	Following Full Load	Following No Load‡
1	1.9	2.0†	1.6	1.8
2	1.7	2.0	1.45	1.6
4	1.5	1.7	1.35	1.4
8	1.35	1.45	1.25	1.25
24	1.25	1.25	1.15	1.15

* Special consideration should be given to installations involving exceptional heavy-current designs.

‡ Values for operation "Following No Load" are on the basis that the transformer has been excited for at least several hours' time prior to application of the load. The loads that can be carried following partial load can be determined with sufficient accuracy by direct interpolation.

† It is considered that two times rated load is the maximum that should be carried, regardless of time, without special consideration.

TABLE 2A. SHORT-TIME EMERGENCY OVERLOADS, SELF-COOLED AND WATER-COOLED TRANSFORMERS RATED ABOVE 500 KVA.

Comparison of Interim Report with C-57

Duration of Load-Hours	Times Rated Load			
	Following Full Load Interim	C-57	Following No Load Interim	C-57
1	1.9	1.4	2.0*	1.6
2	1.7	1.3	2.0	1.5
4	1.5	1.2	1.7	1.35
8	1.35	1.15	1.45	1.25
24	1.25	1.1	1.25	1.1

* It is considered that two times rated load is the maximum that should be carried regardless of time without special consideration.

TABLE 3. SHORT-TIME EMERGENCY OVERLOADS FOR TRANSFORMERS RATED 500 KVA AND BELOW,* AND FOR REGULATORS

(Times Rated Load)

Duration of Load, Hours	Transformers 500Kva and Below		Regulators	
	Following Full Load	Following No Load‡	Following Full Load	Following No Load‡
1	1.7	1.9	1.5†	1.5†
2	1.55	1.7	1.5	1.5†
4	1.4	1.5	1.4	1.5
8	1.3	1.35	1.3	1.35
24	1.2	1.2	1.2	1.2

* Special consideration should be given to installations involving exceptional heavy-current designs.

‡ Values for operation "Following No Load" are on the basis that the transformer has been excited for at least several hours' time prior to application of the load. The loads that can be carried following partial load can be determined with sufficient accuracy by direct interpolation.

† It is considered that 1.5 times rated load is the maximum that should be carried, regardless of time, without special consideration.

combined with these emergency hottest-spot temperature limitations. For convenient use the combined data are given in the form of charts.

Fig. 2 shows the curves for self-cooled transformers larger than 500 kva. For example, a 4-hour emergency load following full load at 30 C ambient has a permissible peak of 150 per cent rated.

Similar charts were made for other types of transformers: Fig. 3, water-cooled; Fig. 4, forced-air-cooled; and Fig. 5, small transformers and regulators. The charts all have the same general form but each covers a specific type of transformer.

One point not covered in the report is the possibility of year-round increase in loading based on consideration of year-round ambients. In other words, there is the possibility of balancing high operating temperatures of one part of the year against the low operating temperatures of the other part of the year to give normal life consumption for the year. Several papers have been presented at the AIEE meetings that have attempted to justify increased loading on such a basis. Some of us have just about reached the conclusion that these studies have been based on insufficient climatological data. Considerably more thorough analysis of climatological data is necessary before average yearly ambients can safely be used as a basis of rating.

Conclusion

The principles and facilities for safely overloading transformers as described in this report may be applied to existing or to proposed new equipment, and should be effective in the conservation of war materials. Full consideration should be given to the many cautions and limitations covered in the report. In all cases, before applying the overloads recommended by this report, it would be well to check the overload capabilities of the equipment with the manufacturer.

Residence Blackout Methods and Materials

(*Continued from page* 381)

of blacking out such rooms as have extensive French windows or unusually large expanses of glass. Although it can be done, the process necessitates the imprudent use of a great deal of material and incurs relatively high costs.

4. All things considered, the use of opaque material to effect a complete blackout is conceded to be the safest and most sure course, since it insures satisfactory results without need for illumination measurements, and trial-and-error tests. It can be seen, however, from the study of the blackout material section, that when applied with an informed consideration of all the factors, a number of the low transmission materials can also effect complete obscuration.

It seems reasonable to believe that some means could be devised to help the civilian group avoid unnecessary expenditures and errors in selecting suitable blackout material. As more persons comply with regulations, and as they become more rigidly enforced, it would be extremely helpful if manufacturers and retailers in some way could indicate the actual tested obscuring value on the material itself.

5. It should be emphasized that the simple, though meticulous, moderately-priced methods of blackout developed here cannot be expected to withstand the concussions and blasts that accompany aerial bombardment. As has been stated, under active warfare conditions, only the shelter or refuge room would be occupied. In this room, the mechanical strength of the materials selected for blackout must be considered. The method of application must incorporate flexibility to sway, without light-leak, under varying air pressures.

6. Bombing has not occurred in this country. If it should, a considerable buying wave of blackout materials would immediately arise. Shortages might be expected. At the present, where ordinary air-raid practice periods are called, the simple expedient of turning out lights is practical. The examination of the rooms of the home, the manner of living that would have to be practiced, the type of material to use, and the method of its application should be fully considered so that quick, intelligent action can follow when the constituted authorities ask for cooperation.

7. In areas which are operating merely under dimout regulations, it is not mandatory that all light visible from the exterior of homes—either transmitted over the window area or reflected from minor leaks—be completely obliterated. It is the endeavor of this paper to foresee and to meet the conditions and requirements at such times as complete blackout regulations may be in force.

Grateful acknowledgment is made to Mr. Harold Wachs for his skill and understanding in creating the detail sketches.

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W. A. STANNARD, Consumers Power Co., Grand Rapids, Mich.
H. P. J. STEINMETZ, Public Service Electric & Gas Co., Newark, N. J.
H R. STEVENSON, The Detroit Edison Co., Detroit, Mich.
H. C. THUERK, Bradford Electric Co., Bradford, Pa.
R. H. TILLMAN, Consolidated Gas Electric Light & Power Co., Baltimore, Md.
C. M. TURNER, Ebasco Services Inc., New York, N. Y.
R. P. WAGNER, New York Power & Light Corp., Albany, N. Y.
G. E. WHITWELL, Philadelphia Electric Co., Philadelphia, Pa.
H. E. YOUNG, Northern States Power Co., Minneapolis, Minn.

APPLIANCE MAINTENANCE COMMITTEE

Chairman, M. R. RODGER, Middle West Service Co., Chicago, Ill.
P. W. EVANS, Buffalo Niagara & Eastern Power Corp., Buffalo, N. Y.
CLETUS HANEY, Nebraska Power Co., Omaha, Neb.
H. G. ISLEY, Carolina Power & Light Co., Raleigh, N. C.
W. W. MACKLE, Union Electric Co. of Missouri, St. Louis, Mo.
AUSTIN MONTY, Philadelphia Electric Co., Philadelphia, Pa.
L. R. PARKER, The Commonwealth & Southern Corp., New York, N. Y.
HARRY RESTOFSKI, West Penn Power Co., Pittsburgh, Pa.
BERT W. REYNOLDS, Pacific Gas & Electric Co., San Francisco, Cal.
C. A. STEVENS, Public Service Electric & Gas Co., Newark, N. J.

ELECTRIC WATER HEATING COMMITTEE

Chairman, C. M. TURNER, Ebasco Services Inc., New York, N. Y.
R. S. BELL, The Commonwealth & Southern Corp., New York, N. Y.
R. C. BRYCE, Philadelphia Electric Co., Philadelphia, Pa.
E. M. COBB, Ohio Power Co., Canton, Ohio.
R. E. GALE, Idaho Power Co., Boise, Idaho.
L. F. RIEGEL, Gulf States Utilities Co., Beaumont, Texas.
H. A. WALSH, El Paso Electric Co., El Paso, Texas.

FARM UTILIZATION COMMITTEE

Chairman, C. H. LEATHAM, Monongahela West Penn Public Service Co., Fairmont, W. Va.
MICHAEL A. CAFFREY, Brockton Edison Co., Brockton, Mass.
Robert K. Derry, The Ohio Power Co., Canton, Ohio.

R. T. DUNCAN, The Detroit Edison Co., Detroit, Mich.
E. C. EASTER, Alabama Power Co., Birmingham, Ala.
R. E. HAYMAN, Oklahoma Gas & Electric Co., Oklahoma City, Okla.
C. E. JEERINGS, Rochester Gas & Electric Corp., Rochester, N. Y.
R. T. JONES, Pennsylvania Power & Light Co., Allentown, Pa.
F. W. OHLES, Ebasco Services Inc., New York, N. Y.
J. C. SCOTT, Puget Sound Power & Light Co., Seattle, Wash.
H. A. SMITH, Nebraska Power Co., Omaha, Neb.

HOME SERVICE COMMITTEE

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MISS MARTHA BOHLSON, Nebraska Power Co., Omaha, Neb.
MISS ESTHER LEE BRIDE, Union Electric Co. of Missouri, St. Louis, Mo.
MRS. RUTH BUEL, Indianapolis Power & Light Co., Indianapolis, Ind.
MRS. VERA B. ELLWOOD, Wisconsin Electric Power Co., Milwaukee, Wis.
MISS FANNY MAY IZARD, Mississippi Power & Light Co., Jackson, Miss.
MISS ELIZABETH B. MURRAY, Atlantic City Electric Co., Atlantic City, N. J.
MISS NAOMI D. SHANK, Virginia Electric & Power Co., Richmond, Va.
MRS. ANNE SUTTER, Duquesne Light Co., Pittsburgh, Pa.
MISS CLARA ZILLESSEN, Philadelphia Electric Co., Philadelphia, Pa.

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Vice-Chairman, E. L. KAVANAUGH, The Detroit Edison Co., Detroit, Mich.
F. V. ARMISTEAD, Union Electric Co. of Missouri, St. Louis, Mo.
F. T. BROOKS, Philadelphia Electric Co., Philadelphia, Pa.
H. M. BRUSMAN, Ebasco Services Inc., New York, N. Y.
THOMAS BURNS, American Gas & Electric Service Corp., New York, N. Y.
E. M. CLAPP, Georgia Power Co., Atlanta, Ga.
ROBERT G. ELY, Public Service Electric & Gas Co., Newark, N. J.
J. H. GUMZ, Pacific Gas and Electric Co., San Francisco, Cal.
J. R. HARTMAN, The Cincinnati Gas & Electric Co., Cincinnati, Ohio.
K. K. KREAMER, Houston Lighting & Power Co., Houston, Texas.
P. D. LAWRENCE, Virginia Electric & Power Co., Richmond, Va.
W. P. MCCUTCHEON, Birmingham Electric Co., Birmingham, Ala.
C. H. PURDY, Consumers Power Co., Jackson, Mich.
E. L. ROBINSON, Gulf States Utilities Co., Beaumont, Texas.
CHARLES SNYDER, Monongahela West Penn Public Service Co., Fairmont, W. Va.
W. H. STUEVE, Oklahoma Gas & Electric Co., Oklahoma City, Okla.
C. P. YODER, Buffalo Niagara & Eastern Power Corp., Buffalo, N. Y.

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ROSS BROWN, Indianapolis Power & Light Co., Indianapolis, Ind.
H. B. GOULD, Ohio Edison Co., Youngstown, Ohio.
J. M. GUILLORY, New Orleans Public Service Inc., New Orleans, La.
J. H. GUMZ, Pacific Gas & Electric Co., San Francisco, Cal.
B. J. JENSEN, Public Service Electric & Gas Co., Newark, N. J.
J. E. MUELLER, West Penn Power Co., Pittsburgh, Pa.
PHILIP PEEPLES, Georgia Power Co., Atlanta, Ga.
O. Y. POWELL, Savannah Electric & Power Co., Savannah, Ga.
P. M. RUTHERFORD, JR., Dallas Power & Light Co., Dallas, Texas.
J. S. SCHUCHERT, Duquesne Light Co., Pittsburgh, Pa.
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R. H. THOMPSON, Central Illinois Public Service Co., Matoon, Ill.
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D. M. DEBARD, Stone & Webster Service Corp., New York, N. Y.
R. E. FISHER, Pacific Gas and Electric Co., San Francisco, Cal.
GEORGE W. OUSLER, Duquesne Light Co., Pittsburgh, Pa.
W. E. PARROTT, Ebasco Services Inc., New York, N. Y.
W. H. SAMMIS, The Commonwealth & Southern Corp., New York, N. Y.
H. M. SAWYER, American Gas & Electric Service Corp., New York, N. Y.
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F. E. DAVIS, The Commonwealth & Southern Corp., Jackson, Mich.
PHILIP W. EVANS, Buffalo Niagara & Eastern Power Corp., Buffalo, N. Y.
C. M. FIFE, West Penn Power Co., Pittsburgh, Pa.
G. E. MILLER, The Cleveland Electric Illuminating Co., Cleveland, Ohio.
J. M. TURNBULL, Western Massachusetts Companies, Springfield, Mass.
B. Z. SEGALL, New Orleans Public Service Inc., New Orleans, La.
R. C. WENZ, Duquesne Light Co., Pittsburgh, Pa.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF MARCH 3, 1933

Of EDISON ELECTRIC INSTITUTE BULLETIN, published monthly at Philadelphia, Pa., for October 1, 1942.

State of New York.
County of New York.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Wilgar Coleman, who, having been duly sworn according to law, deposes and says that he is the Editor of the EDISON ELECTRIC INSTITUTE BULLETIN, and that the following is to the best of his knowledge and belief, a true statement of the ownership, management . . . etc., of the aforesaid publication for the date shown in the above caption, required by the Act of March 3, 1933, embodied in Section 537, Postal Laws and Regulations . . . to wit:

1. That the names and addresses of the publisher, editor, managing editor and business manager are: Publisher, EDISON ELECTRIC INSTITUTE, 420 Lexington Avenue, New York City; Editor, Wilgar Coleman, 420 Lexington Avenue, New York City; Managing Editor, none; Business Manager, none.

2. That the owners are EDISON ELECTRIC INSTITUTE, 420 Lexington Avenue, New York City, a mutual organization, not incorporated; Charles W. Kellogg, President, New York, N. Y.; J. C. Leighton, Treasurer, New York, N. Y.; H. S. Bennion, Vice President and Managing Director, New York, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

WILGAR COLEMAN,
Editor.

Sworn to and subscribed before me this 9th day of October, 1942.

(Seal) MAE B. WOODS,
Notary Public, Queens County.
(My commission expires March 30, 1944)

Transmission and Distribution Committee Meeting

E. V. Sayles, *Chairman*

THE Fall meeting of the Transmission & Distribution Committee was held at the Gibson Hotel in Cincinnati, Oct. 19 and 20, 1942. The attendance, although somewhat less than at some previous meetings, was more than might have been expected on account of war conditions and travel difficulties. Approximately 100 registered during this two-day meeting.

The forenoon of the first day was devoted to a discussion of subjects relating to underground construction and cable problems.

G. B. McCabe of The Detroit Edison Co. gave a paper entitled "Results of Emergency Overload Tests on 24-kv Paper and Lead Cable." This paper is concerned in particular with an investigation of the maximum allowable carrying capacities of 24-kv, 3-conductor, paper and lead transmission cable. The study upon which this paper is based had resulted in establishing emergency loadings for these cables, which it was felt can be carried satisfactorily by the cables on infrequent occasions without too much sacrifice in useful life. The program was carried out in conjunction with the development by Mr. McCabe's company, of a method of cooling substation transformers by means of an external water spray which permitted occasional emergency peak loads of more than twice the normal rated capacity of the transformers. It is expected that Mr. McCabe's paper will be published in full in this BULLETIN in the near future.

E. F. Nuezel of Cincinnati Gas & Electric Co. discussed the rejuvenation of old cable with nitrogen gas. He said short lengths of 400,000 cir mils, three-conductor, 15-kv, lead covered, 7/32" x 7/32" belted cable had been removed from service and tested in a laboratory. The selection of this cable upon which their tests had been made was based on its existing high dielectric losses The results of these laboratory tests indicate that cable ratings could be increased approximately 10 per cent without exceeding a maximum cable temperature of 90° C. with the use of nitrogen gas. Tests on reel lengths are contemplated to permit comparison against the test on short lengths made in the laboratory.

Geo. H. Fiedler, Rochester Gas and Electric Corp., described the technical features involved in making the joints in a three-conductor, 750,000 cir mils, compact sector gas-filled Type H cable, that had been installed to serve as an additional tie-line in the re-arrangement of the 11-kv tie-line system in Rochester, N. Y. This presentation was accompanied by several lantern slides which illustrated the procedure followed in making the joints and potheads for this cable installation. Mr. Fiedler said this installation could not be considered as typical from a cost point of view, as some of the cable splicers had been trained to make gas-filled joints and this had resulted in the labor cost being higher than would ordinarily be the case. He also stated that aside from the connection of gas cylinders, the time required to make a joint would not be much different than the time required for the conventional compound-filled type of joint, nor had the workmen encountered any unusual difficulties due to this being a gas-filled cable installation.

A. B. Campbell gave a progress report on the 1941 Cable Operation Report. All of the 1941 data have been received and compiled into preliminary tabular form to permit a general comparison with the data in the 1940 Report (EEI Pub. No. J3).

An interesting discussion was presented by A. Bodicky, Union Electric Co. of Missouri, on cooling cables with water. The abnormally hot and dry summer of 1941, occurring when cables were carrying more load than previously, had resulted in several cable and joint failures in a 3-mile conduit section carrying ten 33-kv cables. Efforts made to relieve this situation by flushing the soil around the conduit through porous drain tile in the earth immmediately over the duct bank, and by placing ice in the manholes, were of doubtful effectiveness. Experience gained in this way, however, had supplied information which proved helpful in more effectively controlling excessive cable temperatures during the past summer when 49 sections of cable were supplied with water from mains tapped in 38 locations. They had found that results fairly satisfactory had been obtained, particularly if the soil is dry and the temperatures of the cable rise above safe values.

T. G. Hieronymus gave an illustrated discussion of repairs made to lead covered cables that had been supported on a river bridge at Kansas City. Various types of supporting arrangements had been used, with the result that in some instances the lead sheath had been damaged. The method of repair described by Mr. Hieronymus, consisted mainly of lead burning with the proper flame. This had produced satisfactory results.

The afternoon meeting on October 19 was held jointly with the Electrical Equipment Committee. M. C. Miller presented a paper entitled "Supplying Kilovar Loads for War Conservation and Economy." Mr. Miller's paper resulted in interesting discussions by several, as this was a method of approach to the problem that had not been given wide consideration previously by these committees. The paper appears in this issue of the BULLETIN.

Also presented during this afternoon meeting was the Interim Report on Guides for Overloading Transformers and Regulators, by M. S. Oldacre, Chairman of the AIEE Transformer Subcommittee. This report was first presented at the AIEE Summer Convention, June, 1942, and has been published in *Electrical Engineering*, September, 1942, as AIEE Technical Paper 42-156. The war situation requires the maximum use of existing materials and the minimum use of new materials. The report summarizes what is believed to be the best available information on overloading transformers beyond Nameplate rating. This includes taking account of ambient temperatures, load factors, design characteristics of the transformers, supplemental cooling, etc., and still obtain normal life from the transformer, or to carry still more load with some sacrifice of the transformer life. Cautions and limitations that should be observed are pointed out, and finally overloads are given that are considered safe for immediate general use for the average modern transformer. It is believed that application of the principles stated in the report will make possible a very considerable saving in copper, steel and the other materials that enter into a transformer.

The forenoon meeting on October 20 consisted of round table discussions on the following:

(a) Transportation Problems under War-Time Restriction.

(b) Present Status of Distribution Transformer Standards.
(c) Dim-Outs of Street Lighting Systems.
(d) Interim Amendments to the 1940 National Electrical Code.
(e) Current Capacity Ratings of Overhead Conductors.

Interesting discussions were held on all the above subjects.

The afternoon meeting on October 20 was a "testimonial" meeting at which twelve men gave brief descriptions of a solution to some specific problem that had arisen from war-time conditions, which required some method of design, construction or operation, that had been necessary because of the shortage of critical materials or because of the urgent service necessary to some war production plant.

Electrical Equipment Committee Meeting

By R. T. Henry, *Chairman*

THE fall meeting of the Electrical Equipment Committee was held in Cincinnati, Ohio, Oct. 19 and 20. About 50 members and guests were in attendance. On Monday afternoon there was a joint session with the Transmission and Distribution Committee on matters of mutual interest. Tuesday was devoted to the closed session dealing with apparatus troubles, emergency ratings for equipment and operating and maintenance problems arising from the war effort.

At these meetings emphasis was placed on informal round table discussions for the exchange of ideas and experiences. The Apparatus and Design Division reviewed in this manner station design problems arising out of the national emergency. Another major item of the program sponsored by the System Engineering Division was a discussion of cases where engineering and ingenuity are being used to operate systems where under present conditions system additions have not been possible due to shortage of critical materials.

Mr. A. V. DeBeech described a new type of electronic tester and a motor driven megger employed for dielectric absorption testing of generator insulation in Brazil. He reviewed the conditions leading up to the decision to embark on this type of testing program and told of some of the experiences obtained.

It was reported that the EEI-NEMA Joint Committee on Preferred Voltages of A-C Systems and Equipment had held a meeting in June and had made considerable progress on its work. Studies are being carried forward by several of its working groups in preparation for another meeting of the joint committee.

Mr. A. E. Silver briefly reviewed the recent meeting of the Meter and Service Committee, which was held jointly with the corresponding AEIC Committee. This was limited to a one-day session with a restricted program of items related to the war effort.

The joint session with the Transmission and Distribution Committee was devoted to the presentation of two papers —one of these by Mr. M. C. Miller, entitled "Supplying Kilovar Loads for War Conservation and Economy," emphasized the possibilities of increasing system kilowatt capability by the strategic use of capacitors to supply reactive kilovolt amperes. The second paper was a discussion of the AIEE interim report on Guides for Overloading Transformers and Regulators by Mr. M. S. Oldacre, chairman of the AIEE Transformer Subcommittee. Both of these created much interest and were actively discussed. These papers are reproduced elsewhere in this issue of the BULLETIN.

A formal report on Apparatus Troubles for the period Feb. 15 to Aug. 15 was presented by Mr. F. S. Brown. This report covered 154 cases of trouble, 17 of which, however, were for the preceding period, but were received too late to be included in the previous report. Of the major cases of trouble those reported most frequently were lightning arresters (27), oil circuit breakers (11), power transformers (8). Among minor troubles those occurring most frequently were power transformers (15), regulators (12), instrument transformers (9), constant current transformers (7). Following the formal report several interesting cases were discussed in more detail.

Mr. R. W. Wilbraham reviewed the Joint EEI-AEIC-NEMA Committee work on oil circuit breakers. The rating tables prepared by the Joint Committee were accepted by the ASA Subcommittee on Oil Circuit Breakers at a meeting on June 29. Revisions were made at that meeting in other parts of the Alternating Current Power Circuit Breaker Proposed Standard which had been available to the industry for more than the one year's trial use for which it was intended. The revised Standard is now being arranged for further review and comments.

Mr. Kent reported that a compromise had been reached on certain points in question in the ASA Standard for Rotating Electrical Machinery and that the revised Standard was submitted to the Sectional Committee for letter ballot last month.

Experience with compressed air circuit breakers was presented by Mr. E. W. Knapp, who also reviewed the considerations leading up to the use of this type of equipment. In the subsequent discussion particular interest was evidenced in the types of problems introduced by the handling of compressed air.

Mr. A. V. DeBeech reviewed foreign developments to bring up to date the information on air raid protection which he presented at the Chicago meeting.* Following this there was an active round table discussion of related problems affecting the utilities in this country.

Mr. C. W. Mayott discussed the provisions of WPB General Limitation Order L 94 and pointed out the type of situation which might call the order into operation.

Mr. E. B. Shew discussed the emergency rating of equipment to take advantage of ability of individual apparatus to carry higher loads during an emergency and to provide maximum flexibility in operation. In this connection reference was made to the value of recognized guides for overloading standard apparatus, such as that for transformers presented by Mr. Oldacre.

* EEI Bulletin, May, 1942.

Lighting Voltage Trend in U. S. A.

Per Cent of U. S. Population in Areas Supplied at Different Lighting Voltages

100-130 Volt Range

Ligthing Voltage Reported	Year 1923	1928	1933	1938	1942
110	36.3%	15.9%	5.2%	1.4%	1.2%
115	40.9	61.6	61.7	49.5	43.5
120	19.4	22.4	33.0	49.0	55.2
Other	3.4	0.1	0.1	0.1	0.1
Total	100.0	100.0	100.0	100.0	100.0
Avg. Voltage of first 3 items	114.1	115.3	116.4	117.4	117.7

The Business of War

(*Continued from page* 358)

ident of Indianapolis Power and Light Company, who last March in Chicago presented a very able paper entitled: "Maintaining Residential Usage by Our Customers," on this very subject. I commend that paper to you for the most thoughtful consideration.)

Importance of Home Front to War Effort

It is often difficult, in the pressure and excitement of a war atmosphere, to make an effective plea for the requirements of civilian life during war time. Such a plea often sounds as though the person who makes it were selfishly interested in his own affairs, rather than in the nation's welfare. I doubt however if any of the dictators we are working to destroy overlooks in his own mind the importance, for his war effort, of a strong sound civilian background. A starved or unhappy citizenship at home has a most depressing effect on the armies in the field. Germany has claimed many times since 1919 that she lost the last war in just this way. The business of modern war is largely transacted on the home front where the weapons are forged that the fighting men use. The huge taxes required to support the war effort must come from the civilian life of the nation; for the fighting forces, from the nature of the case, must of necessity be consumers not producers.

Just as electric power is as useful and necessary for war industry as for peace, so the electric service in the home, meaning as it does cheerful light, food preservation and saving of labor for war effort, is a tangible and effective part of the national life which is devoted to this Business of War. This effective help of electricity in home life can be obtained only if the equipment for utilizing it is in operating condition. The efforts you put forth therefore to keep this equipment in useful condition serve a definite end in attaining the goal we have all set ourselves to reach.

Government Concurs

As an indication that the War Production Board agrees with my general thesis as to the importance for the war effort of civilian activity, may I quote briefly from their Order L-182 of September 30th, wherein, while strictly limiting the manufacture of Commercial Electrical Cooking Equipment, they say, in Section (d): "Nothing in this order shall prevent the delivery of repair or maintenance parts for commercial cooking and food and plate warming equipment."

Coming finally to the third aspect of the electric industry, the manufacture of equipment, I think we can speak with particular enthusiasm and pride of the share the electric manufacturers have borne in this great national effort.

What the Manufacturers Are Doing

While, as has been said, modern war is essentially a machine fight, it is equally true that it is an electrical one. The essential constituents of our planes, aluminum and magnesium, are both made with electricity. No plane or tank could run without electricity. Radio listening and range-finding devices are necessary for protection from submarines and planes. Electric motors and remote electrical control are one thing without which our naval vessels could not function. Electricity furnishes the nervous energy for practically every war machine. This is all because the bigger and more powerful mechanical contraptions become, the more essential becomes their control—and this control is principally electrical. Turbo superchargers have made our flying fortresses the most formidable of the world and electrically heated suits have enabled human beings to fly them without dying of the cold. 800 million candlepower searchlights for spotting airplanes and degaussing equipment against magnetic mines; electric welding equipment and electric steel furnaces; communication apparatus and X-ray machines are but typical of the endless list of electric helpers in the war effort.

Electric Manufacturers Have a Double Responsibility

Many great industries have been able to convert their activities from peace to war work but not so the electrical manufacturers. In addition to producing the vast congeries of special electrical war devices mentioned, they have had to build generating equipment on a scale not before equalled. In the years 1941 and 1942 they will have completed 5,804,000 kilowatts of generating equipment and 3,864,000 kilowatts is on the way for subsequent years; and all of this (over 9,000,000, exceeding any equal period in the history of the utility industry) has had to be superimposed on deliveries of naval turbines of much greater capacity. Electrical manufacturers will produce an estimated $5 billion of electrical products in 1942, an amount about twice as large as the gross revenues of all the electric utilities companies in that year.

In this world-wide life and death struggle, we are pitted against nations who glorify war. One of them is a great industrial and inventive power; another is a master copyist. They are thoroughly regimented and determined, but, on the other hand, they are fighting a combination of many peoples who have a production and combat strength, based in our nation on an electrical pattern, which they cannot match today or five years from today. The all pervading force of electric energy is our power for victory. Our industry, from manufacturer to electrician's helper, has the greatest possible responsibility — on the battle front, in the factory and in the home — to see to it that our electrical pattern is constantly maintained and strengthened. In this responsibility we shall not fail.

Present Value as a Factor in Selection of a Refunding Plan

IN an article, "Present Value as a Factor in the Selection of a Refunding Plan," published in the September issue of the *Journal of Accountancy*, the authors, Messrs. E. S. Loane and A. C. Thomas of the Pennsylvania Water and Power Company, present a simple case study of a regulated hydroelectric utility with a single bond issue outstanding, using present values of future costs and benefits as the basis for weighing the relative advantages of seven alternative refunding proposals and evaluating the results of each method.

The authors conclude that "the most important factor in judging the advisability of a refunding is the numerical expression of the results of the operation. It is the job of the accountant or engineer who is called upon to study a refunding situation to present to management a solution, embracing all factors to which can be given numerical expression, as nearly complete as the available data and methods of analysis will permit. The authors believe that the best and most informative expression of the effect of refunding on the present stockholders can be made in terms of the present value of possible future dividend payments and eventual net worth, determined at a rate comparable to that earned on common-stock equity, or in terms of an average yield on common-stock equity."

Reprints of the articles are available.

PERSONALS

EARLE J. MACHOLD has been elected president and a director of Niagara Hudson Power Corporation to succeed the late Alfred H. Schoellkopf.

Mr. Machold has been closely identified with the operations of the Niagara Hudson System for the past twelve years as counsel for the companies. He was a partner in the law firm of LeBoeuf, Machold and Lamb of New York City from 1930 to date and prior to that time was associated with Attorney Charles A. Phelps at Watertown, New York.

Born in Ellisburg, Jefferson County, New York, in 1903, Mr. Machold graduated from Union Academy of Belleville, New York. He attended Phillips Andover and Syracuse University, obtaining his law degree from Syracuse in 1927. He was admitted to the New York State Bar in 1928.

SAMUEL P. MACFADDEN, vice-president of the Puget Sound Power and Light Company, since 1930, has been elected to the position of executive vice-president, an office left vacant since the retirement of William H. McGrath in 1937.

Four other vice-presidents were also elected by the Board of Directors. They are CHARLES F. TERRELL, PATRICK JOHNSON, CECIL WEBB and LAWRENCE E. KARRER.

Mr. MacFadden received his technical education at Texas A & M College. After spending one year with the Westinghouse Electric and Manufacturing Co., he became identified with the Beaumont Electric Light and Power Company and later with the Eastern Texas Electric Company, both Stone and Webster properties. From 1920-1923 he was assistant to the district manager of Stone and Webster, Inc., at Houston and then was appointed superintendent of light and power of the Eastern Texas Electric Company, Port Arthur. He spent five years with the Western Public Service Company, Scottsbluff, Nebr., before receiving his assignment to the Puget Sound properties.

Mr. MacFadden served as president of the Northwest Electric Light and Power Association last year and while in Nebraska he was president of the Nebraska Section of the former NELA. He is a member of the American Institute of Electrical Engineers.

Mr. Terrell, veteran of Puget Sound's executive staff, joined the company in 1903 while studying electrical engineering at the University of Washington. He has been load dispatcher, wireman, fuel agent, substation construction foreman and superintendent of substations. After an interlude of fifteen years as an executive of utility organizations in Texas and Florida, he returned to Puget Sound as operating manager in 1940.

A graduate of Georgia Tech, Mr. Johnson was engaged in the utility business in Georgia, Illinois and Massachusetts before joining Puget Power. In 1929 he became superintendent of Puget Power's gas division in Bellingham. In 1933 he was transferred to Seattle as assistant to Mr. MacFadden. Three years later he was made assistant general sales manager and in 1937 he was named executive assistant and has devoted much of his time to company condemnation cases and appraisals.

Mr. Webb's career in the electric utility industry began in 1918 in the accounting department of the Galveston-Houston Electric Railway Co. Subsequently he engaged in sales work for the El Paso Electric Company and the Baton Rouge Electric Co. Then he was made superintendent of sales of the Gulf States Utilities Company in Lake Charles, returning to El Paso properties in 1927 as sales manager. A year later he was made division sales manager of the Virginia Electric and Power Company in Richmond and in 1935 he was promoted to assistant general sales manager, the position he held until he was made assistant general sales manager for Puget Sound in 1937. Mr. Webb was chairman of the industrial power and heating subcommittee of the Edison Electric Institute in 1936 and 1937.

Mr. Karrer joined Puget Sound Power and Light Company as a meter tester, following graduation from the University of Washington as an electrical engineer. As a vice-president of the company he will continue as manager of the North Coast Transportation Company, a subsidiary.

The Board of Directors of Public Service Corporation of New Jersey has elected WENDELL J. WRIGHT a director of the corporation and a member of its executive committee, succeeding Edward C. Rose who has been recalled to military service. Mr. Wright has been general counsel of Public Service Corporation of New Jersey and subsidiary companies since 1933. He joined the Public Service law department in 1926.

PRESTON S. ARKWRIGHT, president of the Georgia Power Company, has been appointed to a three-man advisory panel for the sub-office of the Army Ordnance Department which was recently established in Atlanta. This panel will be consulted by Army men for advice on all district matters, such as the selection of key personnel, discussion of why and where new business will be placed, labor problems, the difficulties of small business and other such matters.

C. E. GIESEKER, auditor for Washington Water Power Company since 1935, was elected treasurer of the company at a special meeting of the board of directors. Mr. Gieseker will take over a portion of the duties of L. E. Morse, who has been secretary-treasurer of the company and who remains as secretary. Mr. Gieseker entered the employ of the Washington Water Power Company at Long Lake, Wash., in 1912 during the construction of the Long Lake power station. He was transferred to the accounting department in Spokane in 1918.

JOHN LAWSON has been appointed manager of the customers' service department of the Spokane division of the Washington Power Company. Mr. Lawson succeeds J. E. Winton, recently named assistant treasurer.

ARTHUR HUNTINGTON, a pioneer in the rural electrification movement, and at present public relations engineer of the Iowa Electric Light and Power Company, celebrated last month the completion of fifty years in the electrical industry. Mr. Huntington was one of a committee of three, under the chairmanship of G. C. Neff, now president of Wisconsin Power and Light Company, appointed by the National Electric Light Association in 1919 to meet leaders of agriculture and work out plans for a rural electrification program. The third member of the committee was the late John C. Martin, some years ago Western editor of *Electrical World*. This committee made the basic plans and carried on the first studies of rural con-

sumers and the value of electricity for rural uses.

Mr. Huntington began his career in the electrical industry with the Springfield (Ohio) Electric Light Company as a lineman's helper in 1892. He then entered Ohio State University and following graduation in 1899 he became identified with the Westinghouse Electric and Manufacturing Company at East Pittsburgh, for which he had worked during summer vacations. He was assigned to the Evanston Electric Illuminating Company, where he made valuable studies of power house operation. Westinghouse promoted Mr. Huntington in 1902 to district engineer in the Chicago area and subsequently he was sent to open the Omaha office for the company.

Later he was named president of the Sioux Falls Light and Power Co., Sioux Falls, S. D., and in 1910 he became identified with the Bitter Root Irrigation Company at Hamilton, Mont. In 1916 he joined the Iowa Electric Light and Power Company as public relations engineer and economist. Later, under Presidents Coolidge and Hoover, he was selected to conduct studies and economic developments. In 1933-34 he served as president of the American Society of Agricultural Engineers and was active in the founding of the National Chemurgic Council.

O. J. SCHAEFER, Manager of the Municipal Sales Department, West Penn Power Company, retired from active service September 30.

Mr. Schaefer has given 32 years of service to West Penn, during the greater part of which time he was engaged in the promotion and sale of street lighting. Local district managers will now be responsible for street lighting development and other municipal negotiations. The coordination of this work will be under the general direction of CHARLES V. DOHERTY, who has long been associated with Mr. Schaefer.

JAMES M. STAFFORD, JR., assistant advertising manager, Georgia Power Company, has been appointed state chairman of the payroll savings plan committee of the Georgia War Savings staff. As chairman of the payroll savings plan committee, he will promote the sale of war bonds among employees of business concerns throughout the state.

CONVENTIONS AND MEETINGS

NOVEMBER

2-3 Canadian Electrical Association, Conference of all Committees, Windsor Hotel, Montreal, Can.
9 Industrial Power and Heating Committee, EEI Headquarters, New York, N. Y.
10 Interstate Power Club, Hotel Martinique, New York, N. Y.
10-12 National Association of Railroad and Utilities Commissioners, Coronado Hotel, St. Louis, Mo.
12 Petroleum Electric Power Association, Baker Hotel, Dallas, Texas.

JACK MURRAH, lighting engineer for the Georgia Power Company, at Brunswick, has been transferred to the Atlanta division of the company, succeeding Howard L. McKinley, who resigned to become an instructor in electronics at Georgia School of Technology.

ROBERT E. OSTERHOLM, manager of the industrial department of the Ohio Power Company, in the northern Ohio division, at Tiffin, has been appointed industrial manager of the Canton district.

F. E. PLUMMER has been appointed local manager at Greenville for the Mississippi Power and Light Company. Mr. Plummer has been associated with the company for 15 years and was until his recent promotion a member of the treasury department in the Jackson general offices.

M. A. WOOD, for 15 years chief clerk of the San Luis Obispo district, Pacific Gas and Electric Company has been made district manager, succeeding the late Charles J. Kelley.

Supplying Kilovar Loads

(*Continued from page* 368)

investment is made up of two items, (1) the cost of the capacitors, including automatic control equipment for capacitors where required, at around $10 per kva, plus (2) the increased investment in primaries, transformers and secondaries to carry kilovars in that part of the system beyond the capacitor locations.

It should be pointed out that this investment per kilovar where generated by capacitors, is a minimum figure based on the optimum use on capacitors. This degree probably has been approached on very few systems, and on many systems it may not be economically practicable because of the kilovar capacity already provided in generators and synchronous condensers. Therefore, the investment per kilovar on any system might fall somewhere between these two curves. Curve No. 3 may be more nearly indicative of the incremental investment for serving additional kilovar loads, using capacitors to generate these kilovars.

Summary

It is emphasized that, except for certain comments, the figures of load, voltage and investment given in this paper are only for the specimen or hypothetical system described and are not to be considered as directly applicable to any specific system. However, it is believed that the figures are indicative of:

1. A great amount of recoverable capacity in system facilities now taken up by kilovars generated at power plants and transmitted over considerable distances
2. Possibilities of releasing much of this system capacity to carry increasing kilowatt loads—rapidly, at a low cost, and with a minimum use of critical materials
3. Economies of generating and supplying kilovars close to the load
4. Need for measures to retard and coordinate growth of customers' kilovar loads
5. Desirability of reappraising features of system and equipment design in relation to kilovar loads.

Again, the conviction is expressed that much would be gained by transition to industry-wide use of the concept of the two components of electrical loads—"kilowatts" and "kilovars."

Correction

In the paper "Procedure of Measuring Obsolescence in Machinery and Plants" by Kosmo J. Affanasiev, in the September, 1942, issue of the BULLETIN, the following typographical errors appeared:

Page 345, second column, last paragraph, the description in italics concerning the author's background shows the year of his arrival in this country as 1930. The correct year is 1923.

Page 348, first column, last paragraph, last sentence reads "if the new units were to be *n* service" . . . should read "if the new units were to be *in* service" . . .

Page 349, third column, in the top line which reads "where $e = e'$ and $N = n$ its value *now*," the word now should read *new*

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